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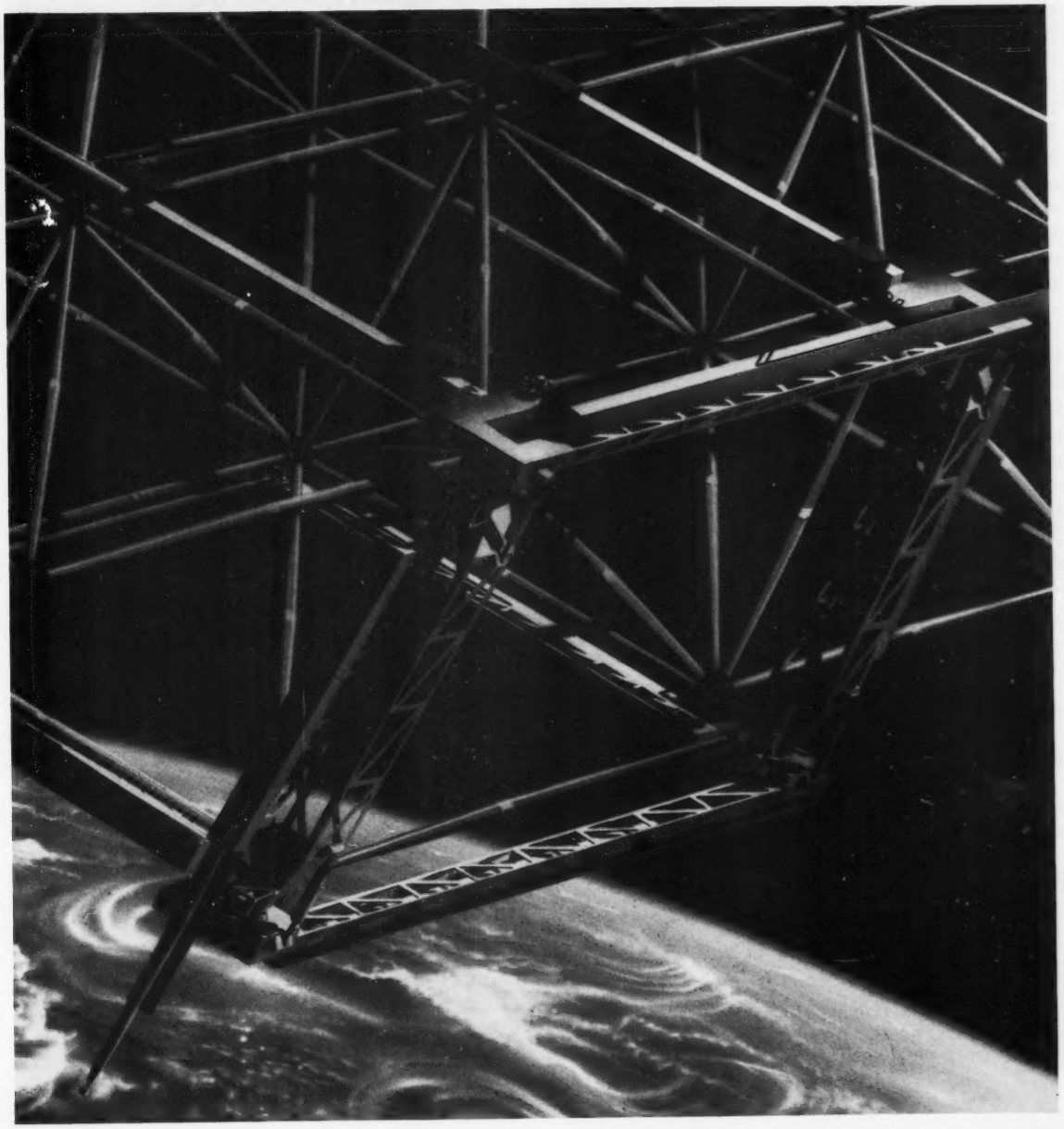

Cover

Space Structures in the Making—Artist's concept of an automatic assembly system that in two days could construct an outer space platform the size of three football fields. Lockheed Missiles & Space Company is conducting a feasibility study of the system under contract to NASA's Langley Research Center in Hampton, Va. The electrically-driven assembly machine permits lateral as well as backward movement. The machine would move along the edge of the platform, installing columns and node joints along the way. Tapered half-columns would be loaded onto the beams of the assembler where the large ends of two half-columns are snapped together for installation into the tetrahedral structure by simple insertion mechanisms. Node joints, necessary to connect the columns that form the platform, are delivered as required from canisters appropriately located on the assembly machine. The assembly machine and the columns would be delivered to space in the Shuttle Orbiter's cargo bay. About 5000 columns could be delivered on each flight.

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Letter from Washington

Dear Colleagues:

During the second week of last June, I had the intriguing and stimulating experience of participating in the New Directions Symposium at Woods Hole, Massachusetts. A few comments on the Symposium and its work may be of interest.

The Symposium was sponsored by the NASA Advisory Council and several members of the Council attended and chaired various working groups. John Naugle chaired the entire meeting. The purpose of the week's work was to explore for new directions in space programs beyond what is presently planned. Four specific areas were examined: the human role in space; life sciences; applications; and solar physics and solar-terrestrial interactions. There was also a fifth, catch-all area to follow up on ideas left over from last year's meeting and to provide a hearing for any other interesting ideas which might crop up outside of the formal four.

The Symposium was attended by about 50 people who were divided almost equally between the five working groups. Attendees were selected by an *ad hoc* committee of the Advisory Council and represented a broad range of scientific and other disciplines from government, industry and the universities. At one end of this spectrum were highly focused solar physicists and at the other end such perceptive generalists as author James Michener, demographer Kingsley Davis, and Dennis Flanagan, editor of *Scientific American*.

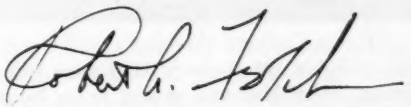
Predictably the ideas developed and the topics considered were as wide-ranging as the intellectual leanings of the participants. Some samples:

- Project Space Watch. What are the chances of an asteroid of significant size colliding with the Earth? What is NASA's role in (1) assessing the probability, and (2) identifying and tracking large earth-orbit-crossing asteroids? If an asteroid were determined to be on a collision course, what kinds of things could we possibly do to deflect it?
- Intriguing and ingenious ideas were developed on how to use existing spacecraft systems in new ways and how to extend existing systems in relatively straightforward ways to obtain measurements which would greatly improve our ability to predict weather and climate.
- Similarly bright ideas surfaced in the area of solar physics, including intriguing concepts for relatively inexpensive (as well as very expensive) spacecraft able to take measurements of the sun of significant scientific value which are not presently possible.
- The door was opened on a whole new investigative field—the myriad biological and chemical cycles between atmosphere and ocean.

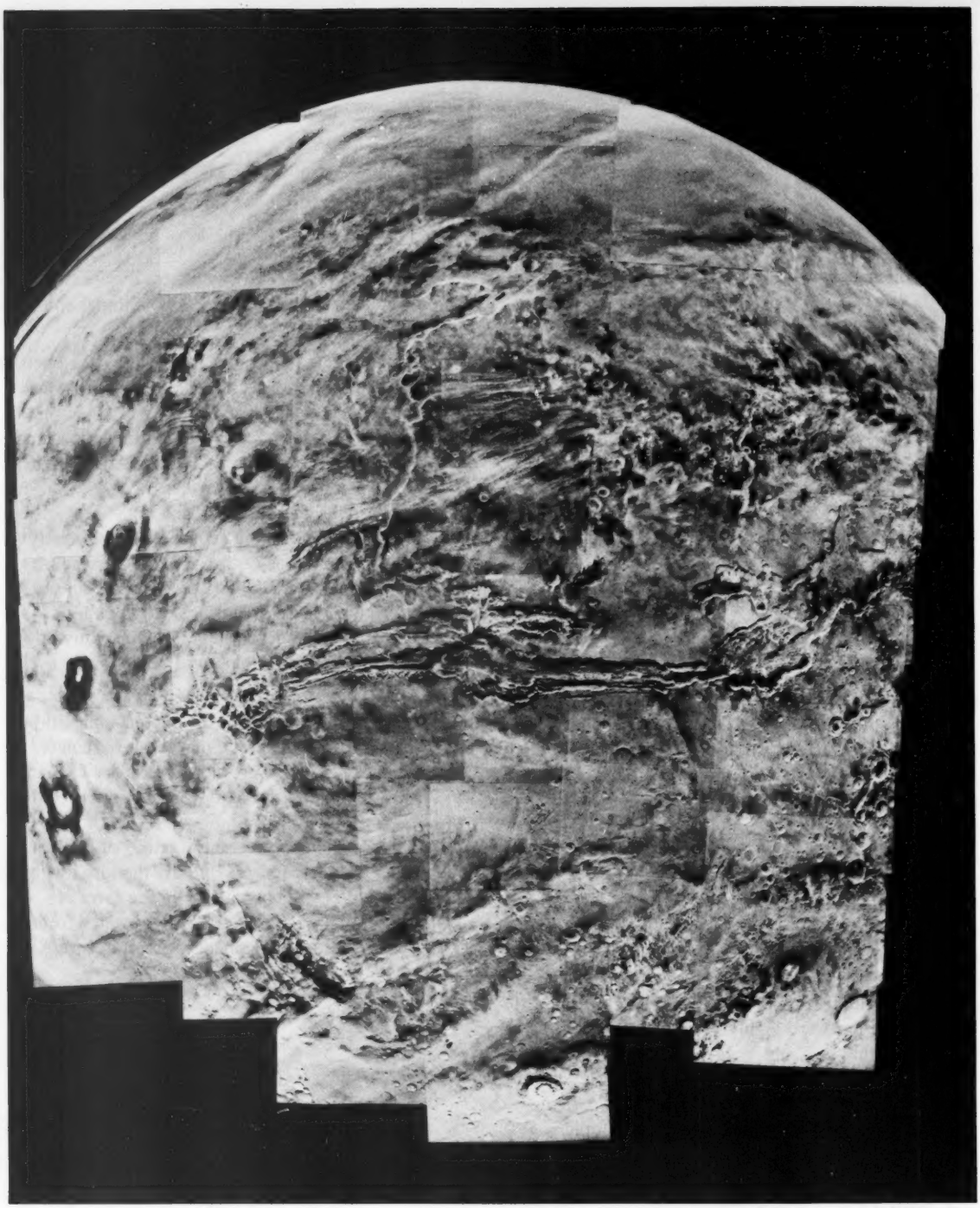
These and other results of the Symposium will be reported in an Executive Summary to be circulated to the attendees, the members of the Advisory Council and NASA management. The working papers of the various groups will be available on request to program offices with a need to know details of the ideas and concepts concerned. Eventually the ideas with the highest potential will come to me in the form of recommendations from the Advisory Council for further study and possible incorporation in future programs.

It was a challenging and rewarding week and some of the ideas generated may well affect our lives in the years ahead.

Sincerely,



Robert A. Frosch



This mosiac of 102 photos of Mars taken Feb. 22, 1980 by NASA's Viking Orbiter 1, shows several prominent Martian features. Valles Marineris, as long as the North American continent from coast to coast, stretches across the center. Three huge volcanoes of the Tharsis are at left: Arsia Mons, Pavonis Mons and Ascraeus Mons (from south to north). A sharp line, either a weather front or an atmospheric shock wave, curves north and east from Arsia Mons. This is the first time a feature like this has been seen.

Viking Discovers Martian Phenomena

Types of weather activity rarely or never before observed on Mars have been discovered in pictures taken by NASA's Viking Orbiter 1 spacecraft. The unusual Martian meteorological phenomena were found in images taken on an exceptionally clear Martian day on Feb. 22. Several prominent features and at least two meteorological anomalies are visible in a mosaic of 102 frames taken that day. The photomosaic is probably the best wide-area view of the Mars surface yet obtained.

The most remarkable weather activity in the mosaic appears as a sharp, dark line which curves north and east from the huge volcano Arsia Mons in the Tharsis Ridge. Scientists believe this line is either a weather front or atmospheric shock wave. Nothing like this weather phenomenon has ever been seen before on Mars.

The second unusual weather activity consists of four small clouds that hover just north of the Lowell crater. Though two of the clouds are so close together as to be almost inseparable even in high enlargement, four clearly separate cloud shadows are cast on the planet surface. The largest cloud is about 32 kilometers (20 miles) in length. Judging from the distance between the clouds and shadows, the clouds float at an altitude of nearly 28 km (17 mi). The shadows, which are cast to the south of the clouds, indicate that the photographs near the center of the mosaic were taken close to noon, local Martian time. Distinct cloud pattern shadows are rarely apparent on the face of Mars.

Viking Orbiter 1, launched Aug. 20, 1975, entered Mars orbit June 19, 1976. It is nearing the end of four years of planetary operation, but continues to transmit an average of 30 pictures a day to controllers at the Jet Propulsion Laboratory, Pasadena, Calif., which manages the Viking project for NASA.

NASA Satellite Records Solar Flare

Scientific instruments aboard NASA's Solar Maximum Mission spacecraft have recorded a 40-minute burst on the Sun's surface which may have resulted in the most significant observations ever made of a solar flare. The flare—covering more than 5.2 billion square kilometers (2 billion square miles) of the Sun's surface—was measured by six instruments aboard the spacecraft on May 21.

Solar flares are sudden, violent explosions in the Sun's atmosphere—an eruption of heat and light that sends shocks and solar gases into space, frequently toward Earth. The intense electromagnetic radiation generated from the flare so disturbed the Earth's ionosphere that radio communications over a broad band of frequencies were lost for more than a half-hour, according to scientists at NASA's Goddard Space Flight Center in Greenbelt, Md. The flare also created a nine-hour geomagnetic storm but it had little other effect on Earth, they reported.

For the first time, the spacecraft's telescopes were able to be focused on the hottest part of a giant flare, indicating—if thermal interpretations are correct—that the flare core temperatures may be more than 56 million degrees Celsius (100 million degrees Fahrenheit). Normal surface temperatures on the Sun range from 4,400 to 5,500 degrees C (8,000 to 9,900 degrees F).

Other measurements made by the spacecraft may shed new light on a controversy that has divided solar scientists for a long time: Do flares resemble the hot, thermal flash that accompanies a blown fuse, or do they resemble the more exotic, non-thermal phenomena seen in laboratory accelerators? The new ingredients that will make scientists take a new look relate to the apparent lack of acceleration of protons in the flare's magnetic field. Previously, scientists believed every major solar flare accelerated protons.

Experiments aboard the spacecraft are expected to tell scientists how solar magnetic fields confine the ionized hydrogen gas until temperatures go above 17 million degrees C (30 million degrees F). This data may in turn provide information on possible new energy mechanisms.

In addition to the scientists at Goddard, other investigators involved in the project include researchers from industry, research institutes and universities. Scientists from eight foreign nations are participating directly in the project, including representatives from Great Britain, France, Germany, Italy, Australia, The Netherlands, Argentina and Japan. Overseen by the International Council of Scientific Unions, more than 400 scientists at 60 institutions worldwide are cooperating with the mission through the Solar Maximum Year—the peak of the 11-year cycle of flares on the Sun.

The Solar Maximum Mission spacecraft was launched from NASA's Kennedy Space Center, Fla., last February to coincide with the peak of the 11-year cycle. The spacecraft is circling Earth at a distance of 500 kilometers (311 miles).

Earth's Magnetic Field Changing

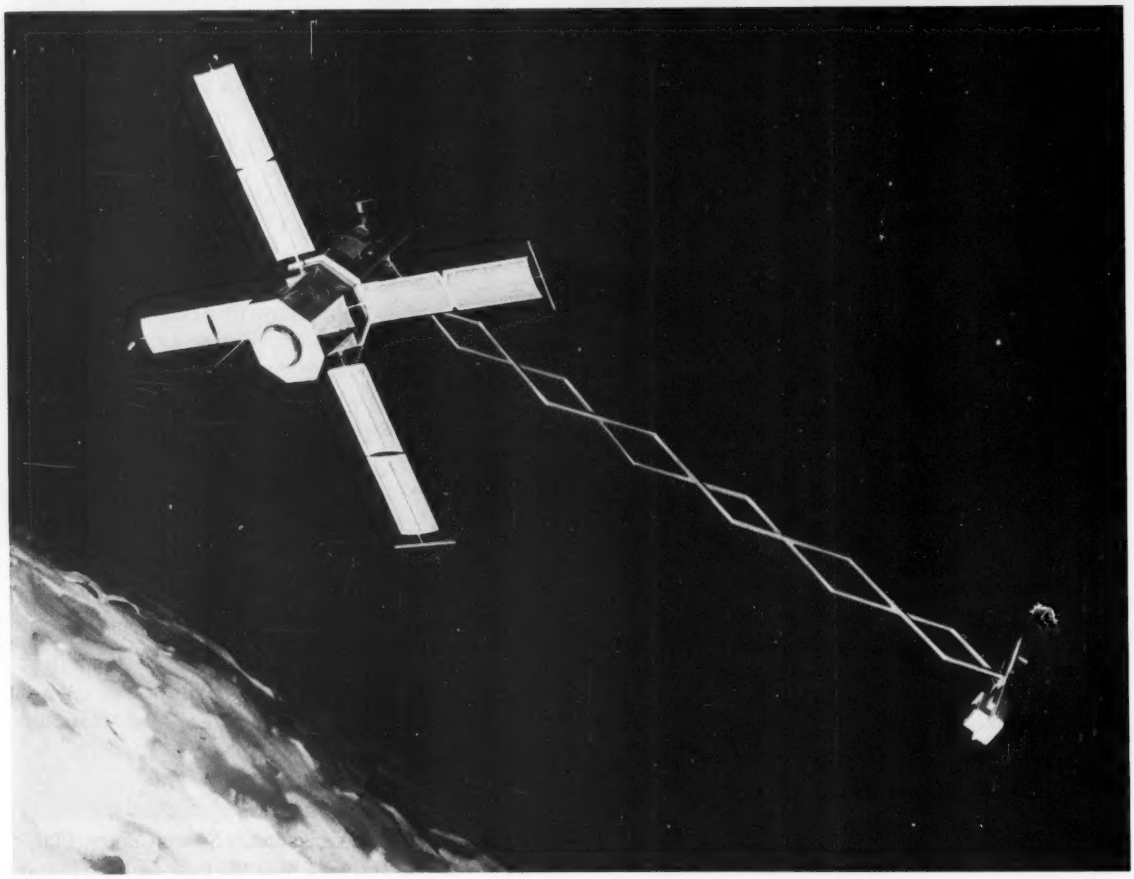
Magsat, a small relatively inexpensive NASA satellite, has provided scientists with data to make the most accurate maps ever of the Earth's magnetic field. The satellite was equipped with two magnetometers, one to measure the magnitude and the other the direction of the Earth's magnetic fields. Initial data from these investigations, published by scientists at Goddard Space Flight Center, Greenbelt, Md., further confirmed the changing nature of the Earth's magnetic field.

Using data gathered from the satellite, scientists have compiled models, or maps, of the Earth with contour lines that delineate regions of abnormal magnetic intensities. It is believed that these magnetic anomalies are related to movement of the Earth's crust and may provide important clues to geologists in search of new mineral and petroleum deposits.

The principal user of Magsat data, the U.S. Geological Survey of the Department of the Interior, has cooperated closely with NASA in setting mission objectives and is participating in the data analysis. The Survey will use Magsat's data to update the agency's publication of magnetic field charts and maps in 1980-81 for navigation and geological use.

Scientists from the United States and eight other countries—Australia, Brazil, Canada, France, India, Italy, Japan and the United Kingdom—are studying Magsat data in 32 investigations in six general categories: geophysics, geology, field modeling, marine studies, magnetosphere/ionosphere and core/mantle studies.

The 277-kilogram (611-pound) satellite, launched in October 1979, re-entered the Earth's atmosphere and crashed into the Norwegian Sea at approximately 3:30 a.m. EDT on June 11, according to a report from the North American Defense Command.



Magsat (Magnetic Field Satellite), the first spacecraft specifically designed to measure the near-Earth magnetic field and crustal anomalies.

Ring May Have Surrounded Earth

A ring similar to the rings surrounding Saturn today may have existed around Earth 34 million years ago, according to a scientist at NASA's Goddard Space Flight Center in Greenbelt, Md. Dr. John A. O'Keefe, of Goddard's Laboratory for Astronomy and Solar Physics, calculates that the ring, composed of tektites (glass meteorites), lasted one to several million years. The shadow of the ring on Earth's surface caused dramatic climatic changes in the temperate zones.

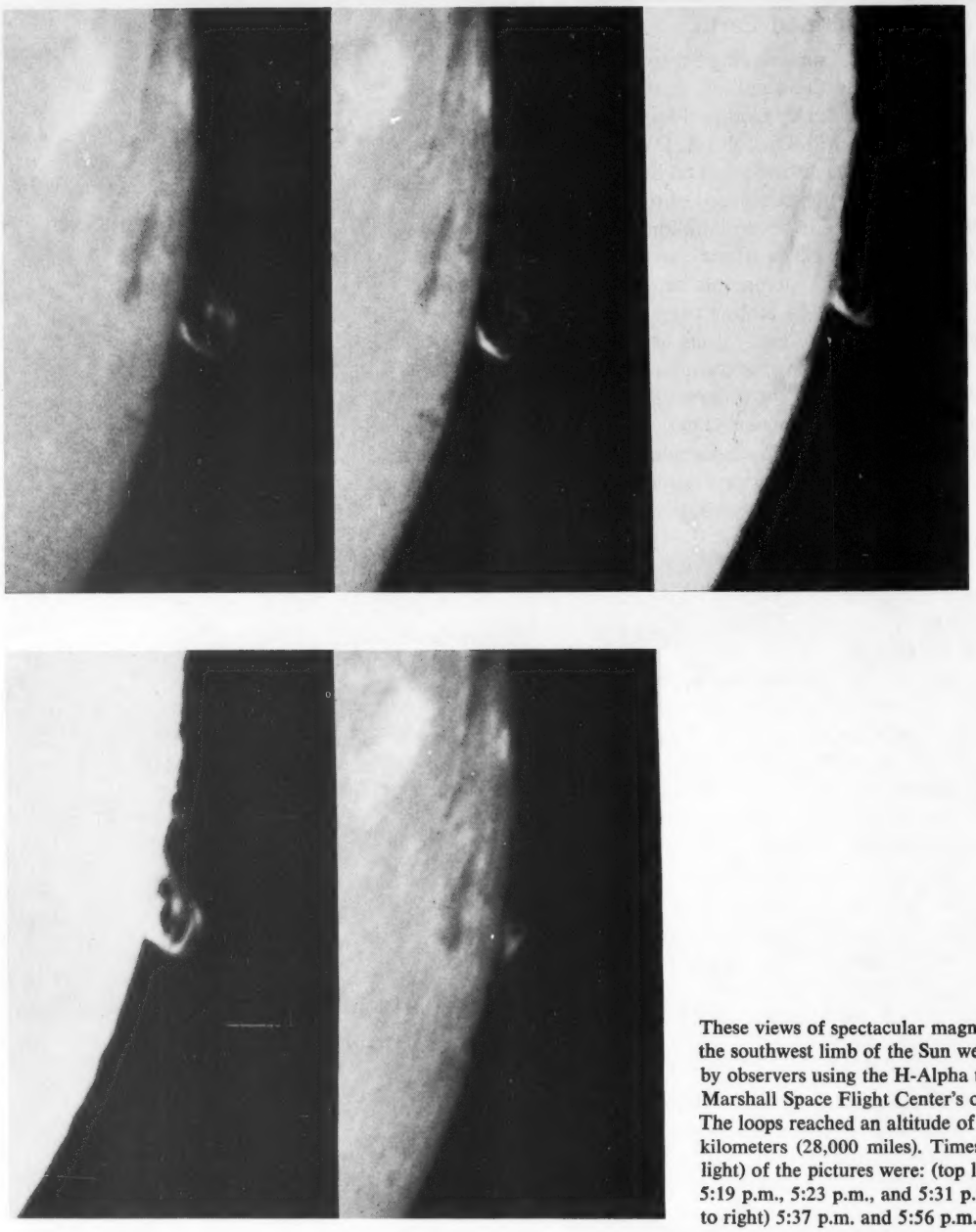
The sudden climatic change 34 million years ago has been known to geologists for many years as the terminal Eocene event. This change is considered to be the most profound climatic event to have occurred during the entire Tertiary period between 65 million and 2 million years ago. (The Eocene era represents the earliest part of the Tertiary period in the Earth's geological history.) Through botanical studies, geologists already had found that the temperature changes occurred at the end of the Eocene but, until now, there has been no acceptable explanation for the occurrence, according to O'Keefe. During the terminal Eocene event, he explained, winter temperatures in the northern hemisphere dropped approximately 20 degrees Celsius (36 degrees Fahrenheit).

The basis for O'Keefe's belief lies in the fact that the biological changes coincide quite accurately with a massive fall of tektites from outer space. While the precise origin of the tektites has not been established, O'Keefe thinks that they might have come from an eruption on the Moon. Studies of the tektites, he said, show that some of them have similarities with rocks brought back from the Moon by American astronauts in the NASA Apollo program. Whatever their source, these tektites crashed into the Earth, leaving a path, or strewn field, extending at least halfway around the Earth, from the eastern United States westward across the Pacific to the Philippines.

O'Keefe suggests that the tektites that missed Earth went into orbit around our planet and organized themselves into a ring like the rings around Saturn. Once formed, the ring blocked out the rays of the Sun in the northern hemisphere in the winter, due to the Sun's location below the plane of the equator. The shadow cast by the rings resulted in the lowering of winter temperatures.

The ring disappeared, O'Keefe believes, when forces in space, such as the pressure of sunlight or the drag of the atmosphere, pulled the particles out of the ring. They were pulled either downward into the atmosphere, where some burned up and others fell to Earth, or upward into space away from the Earth.

Voyager Day at Headquarters—A day of activities commemorating the Voyager Jupiter encounter was held on June 18 at NASA Headquarters. Nineteen scientific papers in four topic areas—the atmosphere; the magnetosphere, flex tube and radio emission; Io and the plasma torus; and Saturn—were presented during a day-long Voyager seminar. In addition, a BBC film entitled "Encounters with Jupiter," a 60-minute documentary describing the results of Voyager's mission to Jupiter was shown for Headquarters employees. NASA's Administrator, Dr. Robert A. Frosch (shown above) activated a Voyager display case whose primary feature is a white-light hologram of Jupiter depicting a three-dimensional rotational movie taken by Voyager I on its approach to Jupiter in March 1979. One complete rotation of the hologram corresponds to one complete Jupiter rotation (or Jupiter day). Additional features of the display are numerous awards presented to the Voyager program.



These views of spectacular magnetic loops on the southwest limb of the Sun were taken May 1 by observers using the H-Alpha telescope at the Marshall Space Flight Center's observatory. The loops reached an altitude of about 45,000 kilometers (28,000 miles). Times (Eastern Daylight) of the pictures were: (top left to right) 5:19 p.m., 5:23 p.m., and 5:31 p.m.; (bottom left to right) 5:37 p.m. and 5:56 p.m.

Giant Solar Loops Detected

Two observers at the Marshall Space Flight Center, Huntsville, Ala., captured on film May 1 giant magnetic loops caused by a flare on the surface of the Sun. These loops were so large—about 45,000 kilometers (28,000 miles) high—that the Earth could have sailed through them with room to spare. The images obtained at Marshall will be used as comparison data valuable to the Solar Maximum Mission because that spacecraft was observing the same area of the Sun at the same time.

Jesse Smith, of MSFC's Space Sciences Lab, was checking real-time X-ray data coming in by computer from the Geostationary Operational Environment Satellite (GOES) when he noticed signs that a flare

was occurring somewhere on the Sun. At that time the Sun was hidden by clouds, and the flare would not have been visible. However, hopeful that the solar cloud cover would lift, he rushed his X-ray data to Dr. Mona Hagyard at MSFC's observatory.

Just as he arrived the clouds parted, and the Sun came out. "We were then able to spot the loops forming on the southwest limb of the Sun," he said. Hagyard and Smith photographed the event at intervals through the H-alpha telescope for more than one hour. "The flare took place behind the Sun," Smith explained, and the loops formed high above the limb, the particles falling back spectacularly along the magnetic 'legs' of the loops."

Smith said photographing images of solar loops is "very rare" due to a number of factors. Loops usually occur months apart; they are often not aligned so that they are visible from a broadside perspective; clouds often cover the Sun while loops occur; sometimes the event happens when it is nighttime at the observer's site; and sometimes the observers are occupied with other matters and fail to catch the event.

The group of observers at Marshall is providing ground based data in support of the Solar Maximum Mission.

Largest In-Space Metal Produced

NASA launched its seventh Space Processing Applications Rocket (SPAR) May 14 from the White Sands Missile Range, N.M. The rocket carried a payload of three materials-processing in-space experiments and was one of a series of SPAR flights that were initiated in 1975 by the Marshall Space Flight Center, Huntsville, Ala. The flights offer materials-processing scientists an interim opportunity, between the Apollo and Shuttle programs, to perform additional research in space processing methods, materials and experiment hardware.

One of the experiments in SPAR's flight was a metals casting experiment by Dr. Mary H. Johnston, a metallurgist at Marshall. The resulting 10.6-ounce (301-gram) sample is possibly the largest materials-casting experiment sample ever formed in space.

Dr. Johnston and Richard Parr, science advisor for the experiment will analyze the casting process and the resulting material to determine whether low-gravity processing can produce a more uniform distribution of elements than when processed on Earth.

Dr. Taylor Wang, a senior scientist at the Jet Propulsion Laboratory in Pasadena, Calif., was responsible for the other two experiments. Both of these used acoustic levitation in which sound waves suspend materials in mid-air while they are being processed. One of these experiments was to determine whether liquid drops can be manipulated in levitation and to study the resulting low-gravity mixing process. In the other experiment, air was injected into a droplet during the low-gravity time period to find out whether the air bubble would form a perfect sphere in the exact center of the droplet. This experiment, if successful, could lead to the manufacture in space of the glass microspheres necessary to nuclear fusion.

Roger Chassay, manager of the SPAR project at Marshall, reported that the Black Brandt rocket used in the flight performed well and that recovery was routine with no significant exterior damage to the payload. Two more SPAR launches are planned later this year.

A 10.6-ounce casting of a tin and lead alloy processed during the low gravity phase of the flight of the Marshall Space Flight Center's seventh SPAR (Space Processing Applications Rocket) flight May 14. This sample is possibly the largest ever formed in space.

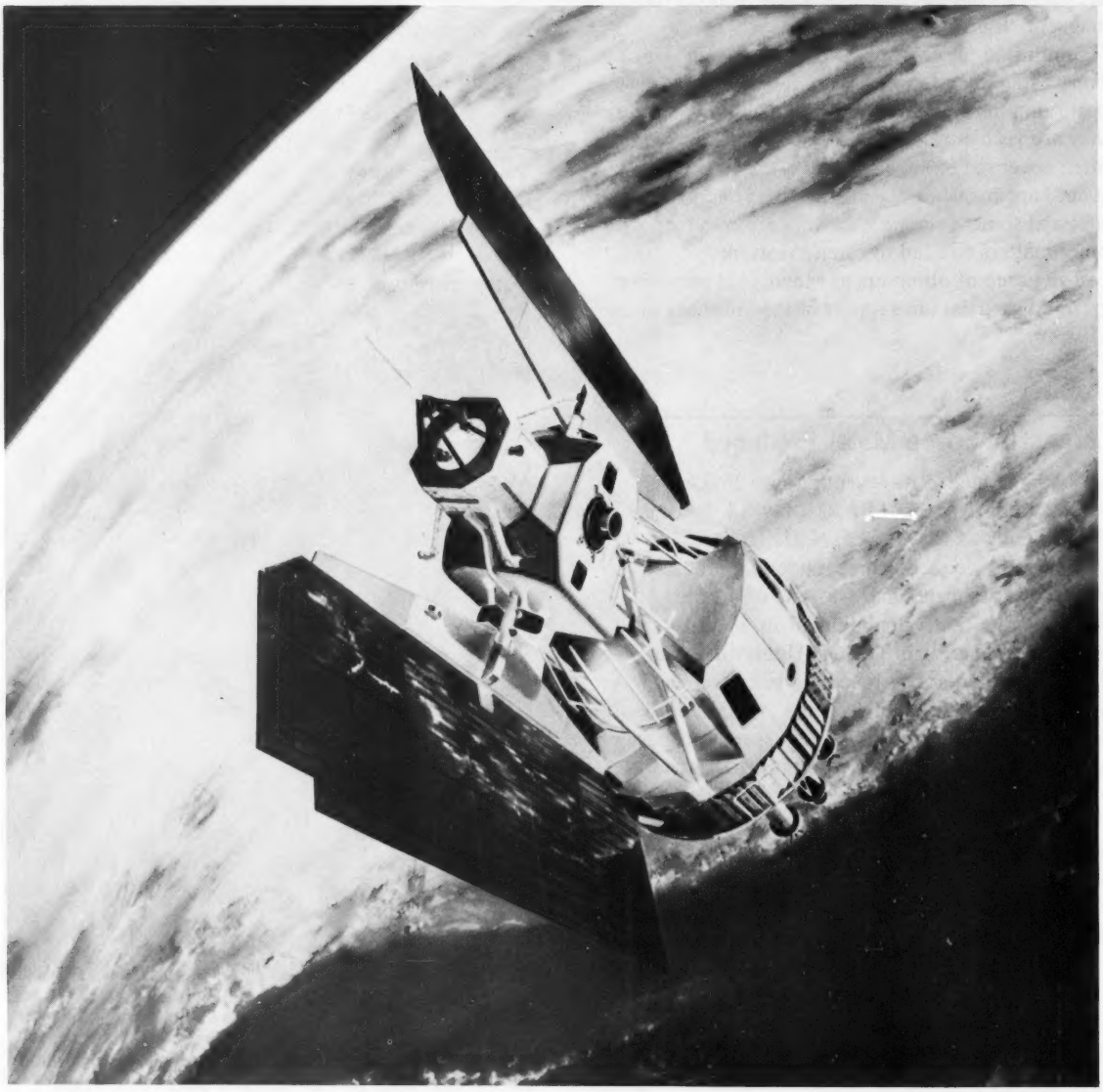
Landsat-2 Back in Service

After almost six-months retirement, NASA's five-year-old Landsat-2 spacecraft is back in service. The spacecraft, designed to study Earth resources from space, was "revived" following intensive efforts by engineers at NASA's Goddard Space Flight Center, Greenbelt, Md., to restore operations and through the development of a new "magnetics" technique which helps keep the polar-orbiting spacecraft stabilized.

The problems with the spacecraft developed on Nov. 5, 1979, when the satellite's yaw attitude flywheel, part of the mechanism that kept it pointed toward Earth, stopped functioning. The malfunction is thought to have been caused by a lubrication breakdown.

Without the flywheel functioning, the attitude-control system was unable to keep the spacecraft stabilized sufficiently to acquire pictures of the Earth. In addition, the spacecraft could not be maintained in an attitude that would permit its solar panels to collect the unnecessary energy from the Sun.

Because of those conditions, the spacecraft was "retired" on its fifth birthday, Jan. 22, 1980. At that time, Goddard engineers began an intensive effort to



Artist's concept of Landsat-2, the second earth resources satellite.

develop a technique to control the spacecraft using a magnetic compensation system that perhaps would restore control. In effect, they were faced with developing a new method of attitude control without the use of the flywheel and without the use of attitude control system gas, which had become depleted.

The engineers faced a number of problems in trying to develop control through magnetics. Among them was insufficient prelaunch knowledge of the spacecraft's magnetic characteristics which would be necessary for interaction with the Earth's magnetic field. In addition, the spacecraft has no direct yaw attitude measuring system, so that an indirect method had to be developed using the solar array output, which varied with the spacecraft's attitude and with its latitude position around the Earth.

Periodically during the development testing, attempts were made to reactivate the yaw flywheel. On May 5, 1980, apparently as a result of a redistribution of the lubricant, the flywheel responded to an "on" command and started running again.

With the yaw wheel operating, normal attitude control was able to keep the proper spacecraft attitude toward the Earth and the Sun. However, with the gas supply depleted, the magnetic system is required to keep the roll-and-yaw-axes flywheels in a safe range. The experience gained while attempting to control the spacecraft attitude with magnetics enabled this technique to be used to control the wheel speeds without developmental delays.

Goddard engineers believe development of the new operating procedures will allow Landsat-2 to operate near its previous capacity, although this will be limited to the direct readout mode since the Landsat-2 tape recorders are not functioning. The return to operational status is of significant importance in that the principal Earth imaging device, the Multispectral Scanner will once again provide Earth imaging data to three U.S. and nine foreign sites, thus supplementing Landsat-3 operations.

Space Antenna Study

NASA's Marshall Space Flight Center, Huntsville, Ala., has selected two firms for negotiations leading to parallel contracts for concept-definition studies of an experimental deployable space antenna. The 12-month studies, to be performed by the Grumman Aerospace Corp., Bethpage, N.Y., and the Harris Corp., Melbourne, Fla., will define the concept for a spaceflight experiment that would demonstrate, in low Earth orbit, the characteristics and performance capabilities of a large space antenna system.

Such a system, if put into wide use, could revolutionize communications, radar and radiometry operations from satelites. An evaluation of future requirements in these fields already has shown that large antenna systems in space will improve service in communications, Earth resources surveys, weather research, and other services now being provided by dozens of small satellites.

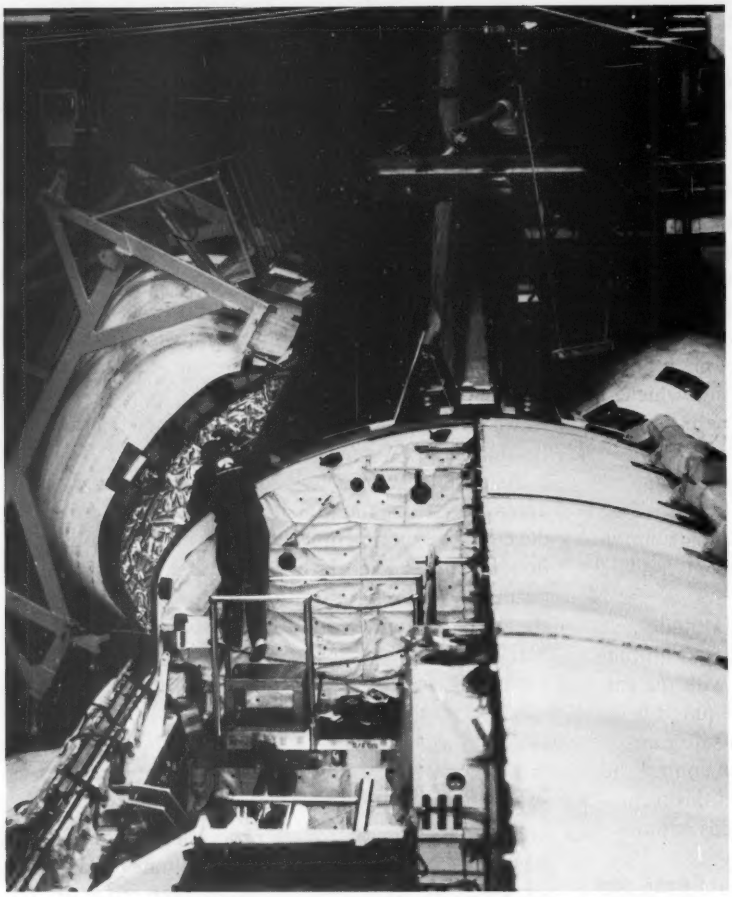
The growing number of communications satellites is rapidly depleting available transmission frequencies, requiring more and more large ground stations, and filling up available parking space in required orbits. Earth resources and weather research need better resolution and wider bandwidths.

As a step toward actual development of large space antenna systems, the Marshall Center proposes to develop an experimental space antenna that could be flown in low Earth orbit for test and demonstration purposes. This demonstration, to be defined in the studies by Grumman and Harris, would verify the antenna's structural integrity and test methods of packaging, transportation and orbital deployment.

Shuttle Propulsion Test Successful

The Space Shuttle's main propulsion system was successfully test fired for nine minutes and 38 seconds May 30, exceeding the duration required to place a Shuttle in orbit. The firing brings the total test time on the main Shuttle propulsion system, which consists of three engines, an External Tank and associated parts of the Orbiter, to 41.3 minutes—nearly three quarters of an hour of firing. This is in addition to the more than 20 hours of single engine tests that have been conducted in a separate program.

The main propulsion system test was conducted by the Rockwell International Space Systems Group, under the direction of NASA's Marshall Space Flight Center, Huntsville, Ala. Bob Bush, Marshall's resident manager of test operations at the National Space Technology Laboratories in Bay St. Louis, Miss., where the tests are conducted, said that the test met all its objectives. The Shuttle's engines were gimballed (steered) while firing, and they were throttled in stages from 100 percent of rated thrust down to 65 percent. The Shuttle will have the first man-rated engines capable of throttle control during flight.



Columbia's Right-Hand Maneuvering System—The right-hand maneuvering system on the Space Shuttle Orbiter *Columbia* is shown being installed at the Kennedy Space Center's Orbiter Processing Facility. Engines in both the left and right-hand pods provide the thrust to insert the Orbiter into final orbit after the main engine has cut off and the External tank has been jettisoned. The pods also maneuver the Orbiter in space for orbit changes, rendezvous with other spacecraft and return to Earth.

Shuttle Engines Flight Tests Completed

The last of the Space Shuttle Orbiter *Columbia's* three main engines successfully completed its second flight acceptance test June 16 with an eight minute and 40 second ground test run that exceeded the time required to put a Shuttle into orbit. All three engines now will be returned to the Kennedy Space Center, Fla., where they will be mounted on the vehicle before its maiden flight into space.

During the firing, engine number 2007 underwent throttling and gimballing exercises to test its ability to change speed and direction after liftoff. The other two flight engines, numbers 2005 and 2006, successfully completed their second flight acceptance test on June 2 and June 5, respectively, reaffirming the readiness of the three engines for flight.

The three engines had previously demonstrated their flight readiness in test firings last year. Since that time, several modifications and component replacements had been made and NASA felt it advisable to retest the engines. Successful retest of the three engines after the modifications and component replacements further verifies the design feature of the engines of replacing components on-line as will be required for its reuse capability.

Single Shuttle engines have accumulated more than 73,000 seconds (20 hours plus) of static test firing thus far, and engines clustered in main propulsion system testing have accumulated an additional 7,000 seconds (110 minutes).

One of the single engines being tested, number 2004, has completed two series of preliminary flight certification tests at 100 percent of rated power level, a series of three full-power tests at 109 percent, and will begin a series of tests at 102 percent later in June. This particular engine has accumulated almost 13,000 seconds of firing time, enough for more than 25 flights of the Space Shuttle.

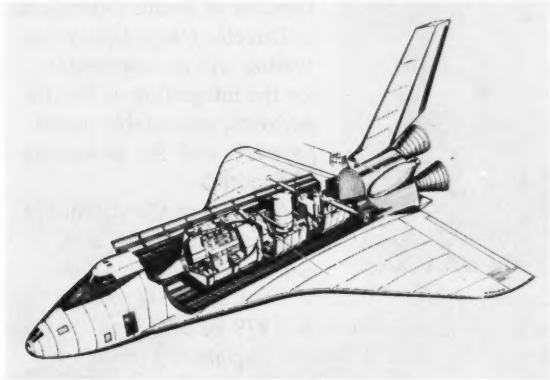
Second Spacelab Subsystem Ordered

NASA has ordered a second Spacelab Instrument Pointing System from the European Space Agency and its contractor, Dornier Systems of West Germany. This equipment, which is a major Spacelab subsystem, is valued at about $20 million.

The Instrument Pointing System is a three-gimbal device which will be mounted on a Spacelab pallet in the payload bay of the Space Shuttle Orbiter to provide highly accurate pointing capability for scientific instruments which require greater accuracy and stability than can be provided by the Shuttle itself. This system has the capability to lock onto and accurately track scientific targets such as stars, solar flares, or specific points of interest on the Earth's surface, unaffected by slight changes in Shuttle attitude.

The number of experiments currently planned demand such accurate pointing that a second unit had to be purchased. This second system supplements the first pointing system that NASA is to receive as part of the basic Spacelab equipment from the European Space Agency. Earlier this year NASA signed a contract with the European multi-national agency for the procurement of a second Spacelab flight unit. This new order will mean that both Spacelab flight units can be equipped with an Instrument Pointing System.

The Marshall Space Flight Center, Huntsville, Ala., is NASA's lead center for Spacelab development under the direction of the Office of Space Transportation Operations at NASA Headquarters. The first flight of Spacelab is set for May 1983.



Schematic diagram of Spacelab's payload facility. Spacelab, a joint venture of NASA and the European Space Research Organization (ESRO), is one of a number of different payloads that will be carried into space in the huge cargo bay of the Space Shuttle. The Spacelab will remain in the cargo bay for missions lasting from seven to 30 days.

Marshall Conducts Thunderstorm Observations

A NASA U-2 aircraft was used in a Marshall Space Flight Center experimental program in May which ranged from Rapid City, S.D., to Oklahoma and Texas. The Thunderstorm (lightning) Overflight Program was carried out by O. H. Vaughan of Marshall's Space Sciences Lab who made simultaneous ground measurements from the Severe Storms Lab of the National Oceanic and Atmospheric Administration at Norman, Okla. Vaughan said the pilot of the U-2, which was based at Ames Research Center, Mountain View, Calif., activated four experiments in the aircraft experiment bay as he flew at altitudes up to 65,000 feet (19,800 meters). Objective of the flights was to get optical, photographic, electrical and spectrographic data on lightning as the plane flew above severe weather formations.

Other investigators involved were Drs. Bernard Vonnegut and Richard Orville of State University of New York at Albany, Dr. Marx Brook of New Mexico Institute of Technology, and Dr. Dave Rust of the Severe Storms Lab. Dr. John Arvesen provided support and coordination from Ames.

Shuttle Special Support Structures

The Marshall Space Flight Center, Huntsville, Ala., is directing the development of special support structures to be used in the Space Shuttle Orbiter on an early flight in which experiments do not constitute a complete Shuttle payload. Two basically identical experiment equipment-support structures will be carried in the cargo bay holding three major experiment systems which are parts of a mixed cargo on the OSTA-2 mission scheduled for launch in 1982.

Each unit will be a basic truss structure made from 4x4-inch square aluminum hollow beams. The structures will be the same width as the cargo bay and will have triangular bases reaching to an attach point in the bottom of the cargo bay. Control weight is 1,200 pounds. The structures are to be designed, manufactured and assembled by Teledyne Brown Engineering Co. of Huntsville, Ala., under contract with Marshall.

The OSTA-2 flight will include elements of a cooperative mission between NASA and the Federal Republic of Germany. The experiments to be mounted on the structures include Marshall's MEA (Materials Experiment Assembly), Germany's MAUS (Materialwissenschaftliche Autonome Experimente Unter Schwerelosigkeit) and a solar array experiment.

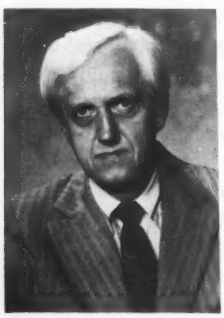
KSC Promotes Four Top Managers

Four new appointments of top managers for the Kennedy Space Center have been announced by Center Director Richard G. Smith. *Raymond L. Clark,* Director of Design Engineering, was named Associate Director for Space Transportation System Development; *Peter A. Minderman,* Director of Technical Support, was appointed Director of Design Engineering; *Thomas E. Utsman,* was promoted to Director of Technical Support; and *Thomas S. Walton* was made Director of Cargo Operations.

As the Associate Director for STS Development, a newly created position, Clark will assist the Director and Deputy Director during the critical period leading to the initial Space Shuttle launch. Smith says, "Clark's principal responsibilities will be to maintain technical cognizance of areas of highest priority and particular sensitivity to the Space Transportation System at KSC and our cargo operations."

Clark began his career at KSC while completing 20 years of active duty with the Army assigned to the Army Ballistic Missile Agency. Following his retirement from the Army in 1966 he was named Director of Technical Support at KSC. In 1972 he was promoted to Director of Design Engineering.

A graduate of West Point and a native Oklahoman, Clark holds a masters degree in aeronautics and guided missiles from the University of Southern California.



Minderman has served as Director of Technical Support since 1972. He joined NASA in 1960 after working in private industry and as a member of the Army's rocket development team. Minderman began his career at KSC as an aeronautical instrumentation research engineer. Later he served as Chief of Telemetric Systems and Deputy Director of Information Systems. In the latter job he played a major role in research and development of ground instrumentation systems related to the Apollo/Saturn V configuration.

A native of Port Clinton, Ohio, Minderman graduated from Ohio State University with a degree in chemical engineering.

In his new position as Director of Design Engineering, Minderman will be responsible for the design and acquisition of ground-support equipment, systems and facilities for launch operations and support elements at KSC.

Utsman, as Director of Technical Support, will be responsible for support services in connection with the KSC checkout and launch operations. A native of Detroit, Mich., he graduated from the University of Michigan in 1958, receiving a bachelor of science degree in mechanical engineering. Utsman continued his education after joining KSC in 1963, earning a master of science degree in management from Florida State University in 1968.

After rising to Associate Director of Design Engineering, Utsman was appointed Director of Operations Management in February 1979. In that position he had been responsible for integrating operational support efforts within the Technical Support Directorate.

Moving up from Deputy Director of Shuttle Operations, to Director Cargo Operations, Walton will be responsible for the integration of Shuttle payloads, expendable rocket payloads and the processing of Spacelab.

A native of Clewiston, Fla., Walton earned a degree in electrical engineering from the University of Florida. Prior to moving to his most recent assignment in 1979 he served as Deputy Director of Shuttle Engineering where his primary responsibility was the development of Shuttle computer programs for the Launch Processing System.

In 1977, Walton was presented the first annual Director's Award, the single highest local honor that can be given a KSC employee.

NASA Selects 19 Astronaut Candidates

NASA has announced the selection of 19 new astronaut candidates for the Space Shuttle Program. The candidates began a one-year training and evaluation program July 7 at the Johnson Space Center in Houston. After the program at Johnson, successful candidates become astronauts and enter the Shuttle training program leading to selection for Shuttle flight crews.

Pilots will operate the Space Shuttle Orbiter, maneuvering it in Earth orbit and flying it to Earth for a runway landing. Mission specialist astronauts will have the overall responsibility for the coordination, with the commander and pilot, of Space Shuttle operations in the areas of crew activity planning, consumables usage, and other Space Shuttle activities affecting experiment operations. They may participate in extravehicular activities (space walks), perform special payload handling or maintenance operations using the Space Shuttle remote manipulator system, and assist in specific experiment operation at the discretion of the experiment sponsor.

NASA received 2,880 applications for mission specialist positions and 585 for pilot positions. Of these, 21 finalists were interviewed and given detailed evaluations at the Johnson Center.

Of the 19 selected, eight are pilot candidates and 11 are mission specialist candidates. Two of the mission specialist candidates are women. One pilot candidate is black and one mission specialist is Hispanic. The new group of candidates includes William F. Fisher, the husband of Anna Fisher, who was selected for the astronaut candidate program in 1978. Six civilians, including three current employees of the Johnson Space Center, and 13 military candidates, one of whom is assigned to Johnson, were selected.

Names of the 19 candidates, their military status, and their type of candidacy are: James P. Bagian, civilian, mission specialist; Lt. Col. John E. Blaha, U.S. Air Force, pilot; Maj. Charles F. Bolden, Jr., U.S. Marine Corps, pilot; Lt. Col. Roy D. Bridges, Jr., U.S. Air Force, pilot; Franklin R. Chang, civilian, mission specialist; Mary L. Cleave, civilian, mission specialist; Bonnie J. Dunbar, civilian, mission specialist; William F. Fisher, civilian, mission specialist; Maj. Guy S. Gardner, U.S. Air Force, specialist; Maj. Guy S. Gardner, U.S. Air Force, Capt. David C. Hilmers, U.S. Marine Corps, mission specialist; Lt. David C. Leestma, U.S. Navy, mission specialist; John M. Lounge, civilian, mission specialist; Maj. Bryan D. O'Connor, U.S. Marine Corps, pilot; Lt. Cmdr. Richard N. Richards, U.S. Navy, pilot; Capt. Jerry L. Ross, U.S. Air Force, mission specialist; Lt. Cmdr. Michael J. Smith, U.S. Navy, pilot; Maj. Sherwood C. Spring, U.S. Army, mission specialist; and Maj. Robert C. Springer, U.S. Marine Corps, mission specialist.

Effects of Weightlessness—NASA's Ames Research Center, Mountain View, Calif., conducted a three-week study in April-May 1980 to determine the effect of weightlessness upon the body. For this study, prolonged bedrest is used to simulate weightlessness. Subjects perform a bicycle exercise as shown in photo before the experiment to help scientists determine the condition of their cardiovascular systems prior to the test. At the conclusion of the experiment, the subject must again bicycle before rising to show whether the heart has deconditioned while lying in bed. Shown bicycling is subject Frank Holland. At 57, he is one of the oldest human volunteers ever tested in this experiment.

Shuttle Recovery Contract Awarded

United Space Boosters, Inc., has been awarded a contract to establish and operate a two-ship recovery force to retrieve expended Space Shuttle solid rocket boosters from the Atlantic Ocean. The firm is a subsidiary of United Technologies Corp., Chemical Systems Div., Sunnyvale, Calif., and is located in Huntsville, Ala. The contract will be managed by the John F. Kennedy Space Center, Fla.

The $7,231,000 agreement formalizes a letter contract issued July 13, 1979, and covers the period through Feb. 28, 1982. Options for the two specially constructed recovery vessels to be operated by the company under the contract extend for a 14-year period through Feb. 28, 1995. The agreement supplements a contract under which the firm

The launching of the UTC Liberty, one of two recovery ships to be used by NASA to recover the expended Space Shuttle solid rocket boosters from the Atlantic Ocean. The new vessels were designed for United Technologies Corp., United Space Boosters, Inc., by Rudolph T. Matzer and Associates, Jacksonville, Fla., and are under construction by Atlantic Marine, Inc., Fort George Island, Fla.

assembles and processes solid rocket boosters for flight, bringing the total current value of the parent contract to $17,718,000.

Under the recovery contract, United Space Boosters, Inc., is to deploy a force to locate and retrieve expended solid rocket booster casings, parachutes and other flight elements from the Atlantic Ocean and deliver them to the Solid Rocket Booster Disassembly Facility located at Cape Canaveral Air Force Station.

The new vessels, of molded steel hull construction, have been designated the UTC Liberty and UTC Freedom. They were designed for United Technologies Corp., United Space Boosters, Inc., by Rudolph F. Matzer and Associates, Jacksonville, Fla., and are under construction by Atlantic Marine, Inc., Fort George Island, Fla. The vessels are to be delivered to KSC in October 1980 and January 1981. Both ships will be used on each Shuttle mission; each can retrieve one booster and associated components.

The retrieval ships will carry the necessary equipment to plug booster nozzle cavities, pump out water in the casings, and bring them into horizontal position for towing back to the Disassembly Facility. Four parachute rollers on each vessel will be used to retrieve the three main and single drogue parachutes on each booster and each ship will be equipped with cranes to hoist collateral flight equipment aboard. The vessels will feature sophisticated electronic communications and navigation equipment that includes a satellite navigation system, search radars, collision-avoidance sonars with transponders, radars, Loran C, VHF and single-sideband high-frequency radio systems, direction finders, fathometers and gyro compasses.

The vessels will be 53.6 meters (176 feet) long, have a beam of 11.3 m (37 ft), a depth of 4.6 m (15 ft), draw 2.7 m (9 ft) of water, and have a displacement of 955 metric tons (1,052 tons).

At sea, propulsion will be provided by twin diesel engines with a combined power output of 2,900 horsepower. Maneuvering ability will be provided by a diesel-driven 425-hp bow thruster. Propulsion in the Banana River, location of the Booster Disassembly Facility, will be provided by a 425-hp waterjet stern thruster in an effort to protect the manatee (or sea cow), an endangered species which make these waters their home. Use of the stern thruster will eliminate danger to the manatees from propellers which can maim or kill the animals. The vessels will have a sustained speed capability of 24 kilometers per hour (13 knots), a range of 11,000 km (6,900 statute miles) and a complement of 24—12 crew and 12 retrieval specialists.

During a launch, two solid-rocket boosters, 45.4 m (149 ft) tall, will burn simultaneously with the Space Shuttle Orbiter's three main engines at liftoff. They will burn for about two minutes before they are jettisoned at an altitude of approximately 45 km (28 mi). The expended booster casings will impact in the Atlantic Ocean approximately 257 km (160 mi) downrange from KSC's Launch Complex 39, each one's final descent into the water slowed by three parachutes, 35 m (115 ft) in diameter.

After return to the Disassembly Facility, the casings will be cleaned and disassembled for shipment to Utah for reloading with solid-rocket propellant. Each casing can be reused for up to 20 missions, substantially reducing the cost of flight operations in the Space Shuttle era.

Marshall to Manage New Solar Energy Systems

The Marshall Space Flight Center has been assigned responsibility for providing technical management for 843 new solar energy systems to be installed in federal buildings across the nation. The Department of Energy announced the selection of the new projects May 29. This brings the total number of solar heating and cooling sites managed by Marshall to more than 1,000.

Almost $32 million in DOE funds have been allocated to Marshall for completion of the 843 new projects. The program includes funding for 734 hot water systems; 16 heating systems; 7 cooling systems; 51 heating, cooling, and hot water systems; 11 industrial process heat systems; and 24 hybrid and passive systems.

The Marshall Center will assign a site manager for each project whose duties will include approving final designs, providing technical assistance, and validating operation and maintenance data. Most of the projects will be completed and in operation within 12 to 32 months after the allocation of funds.

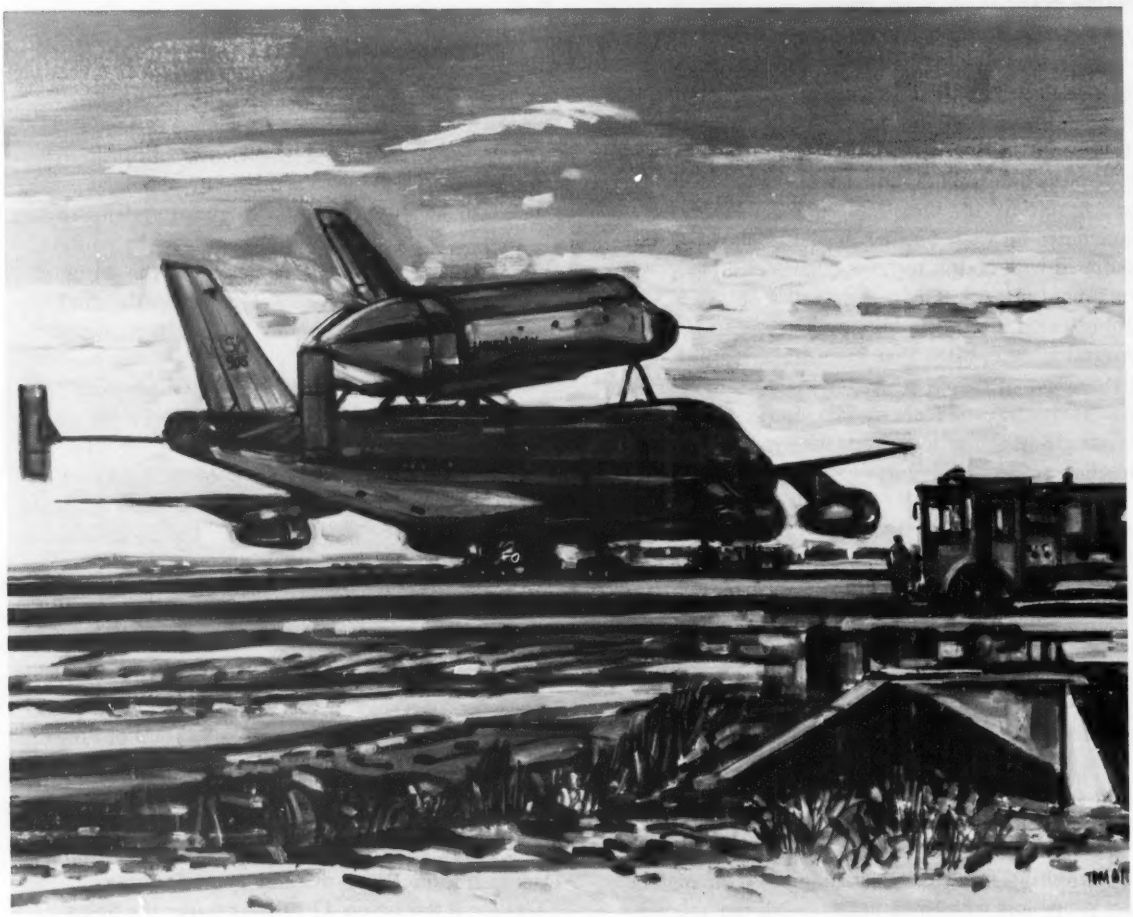
In addition to the Solar Federal Buildings Program, Marshall has provided technical management support to DOE for 117 solar energy systems under the Solar Heating and Cooling Commercial Demonstration Program, and is performing operational testing on 42 systems under the Solar Heating and Cooling Development Program.

NASA's Fine Art Program

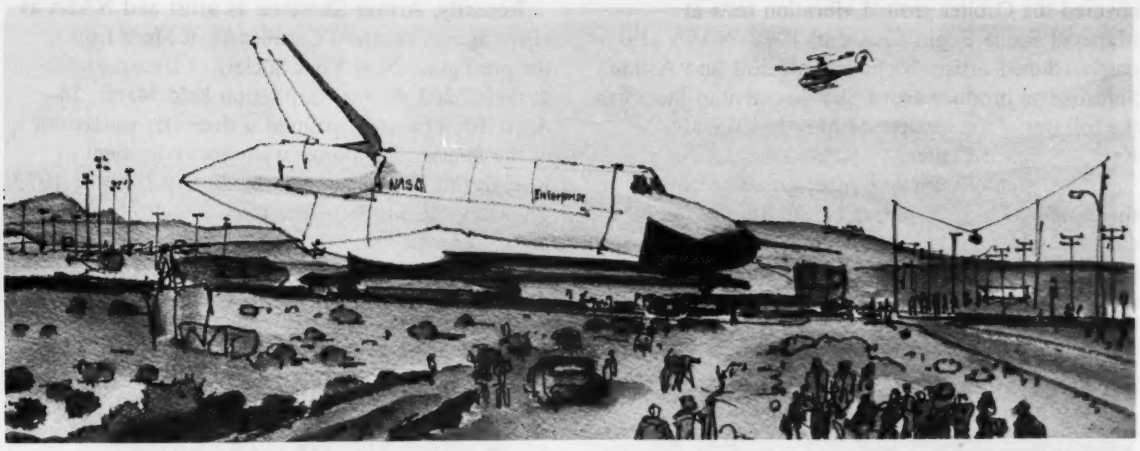
For the past 17 years, NASA has conducted an active art program for the purpose of collecting an archival history of man's exploration of space. Under a mandate to keep the public informed about its progress in space exploration, NASA's art program seeks to provide new insights into various space-program activities. Thus, nationally known artists have been invited to pictorially document major NASA activities. Bob Schulman, NASA Graphics Coordinator, Public Affairs Division at Headquarters, is responsible for the selection and commissioning of artists and management of the program.

Artists participating in this program have ranged from traditionalists, such as Peter Hurd and James Wyeth, to modernists such as Robert Rauschenberg and Lamar Dodd. The art produced varies in style from subjects closely seen and sharply delineated to those only sensed or imagined by the artist. NASA has made it possible for artists to be stationed at the closest observation points to Apollo Saturn moon launchings. They have been aboard recovery ships when astronauts have returned from their long voyages. Artists have piloted Lunar Module simulators to make-believe moons. In short, NASA has tried to provide them with every possible space view and experience.

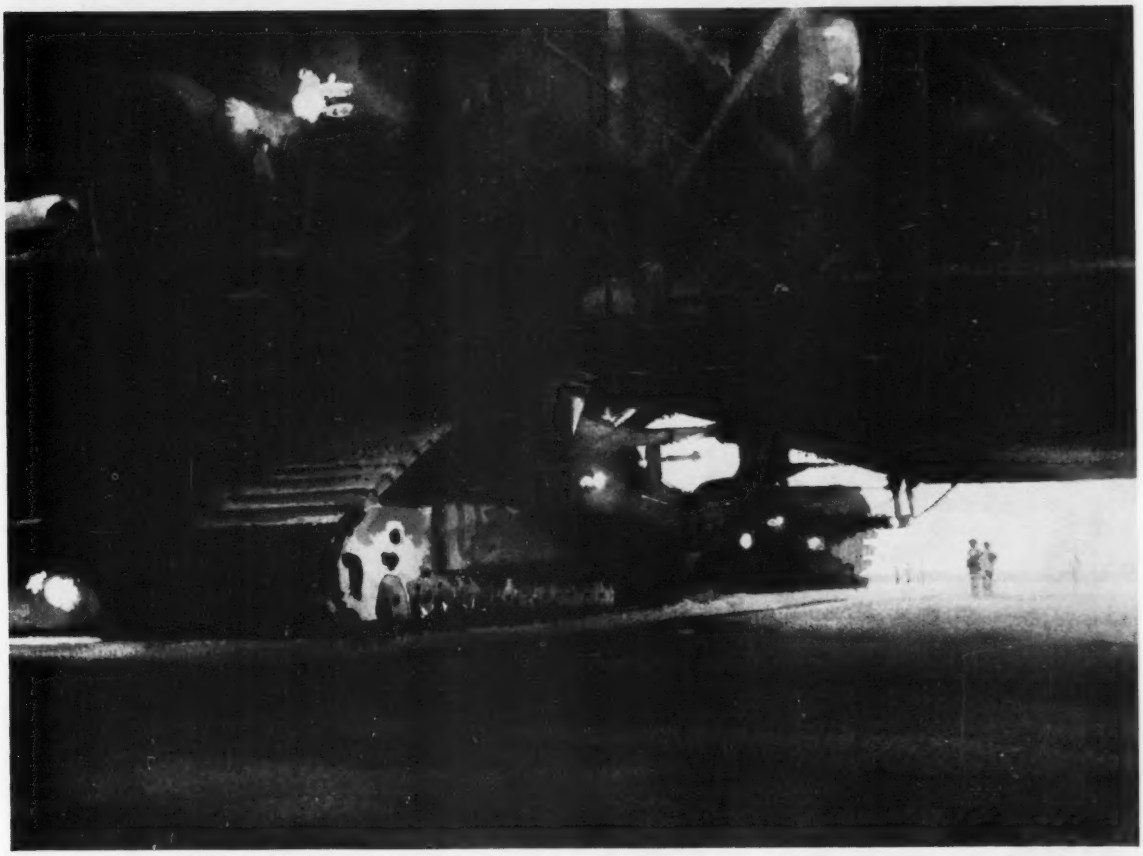
In 1977, NASA commissioned Robert T. McCall to document, in drawings and paintings, activities related to the roll out of the Space Shuttle *Enterprise* at Dryden Flight Research Center. During 1978, artists Franklin McMahon and Tom O'Hara were commissioned to produce works of art documenting the first free-flight of the Shuttle Orbiter. Artists Arthur Shilstone and Clayton Pond



Artist Tom O'Hara's painting entitled "Taxi Orbiter and 747."



Artist Robert McCall's painting depicting the Space Shuttle Orbiter's move from the Rockwell International Assembly Facility at Palmdale, Calif., to the Dryden Flight Research Center at Edwards, Calif.

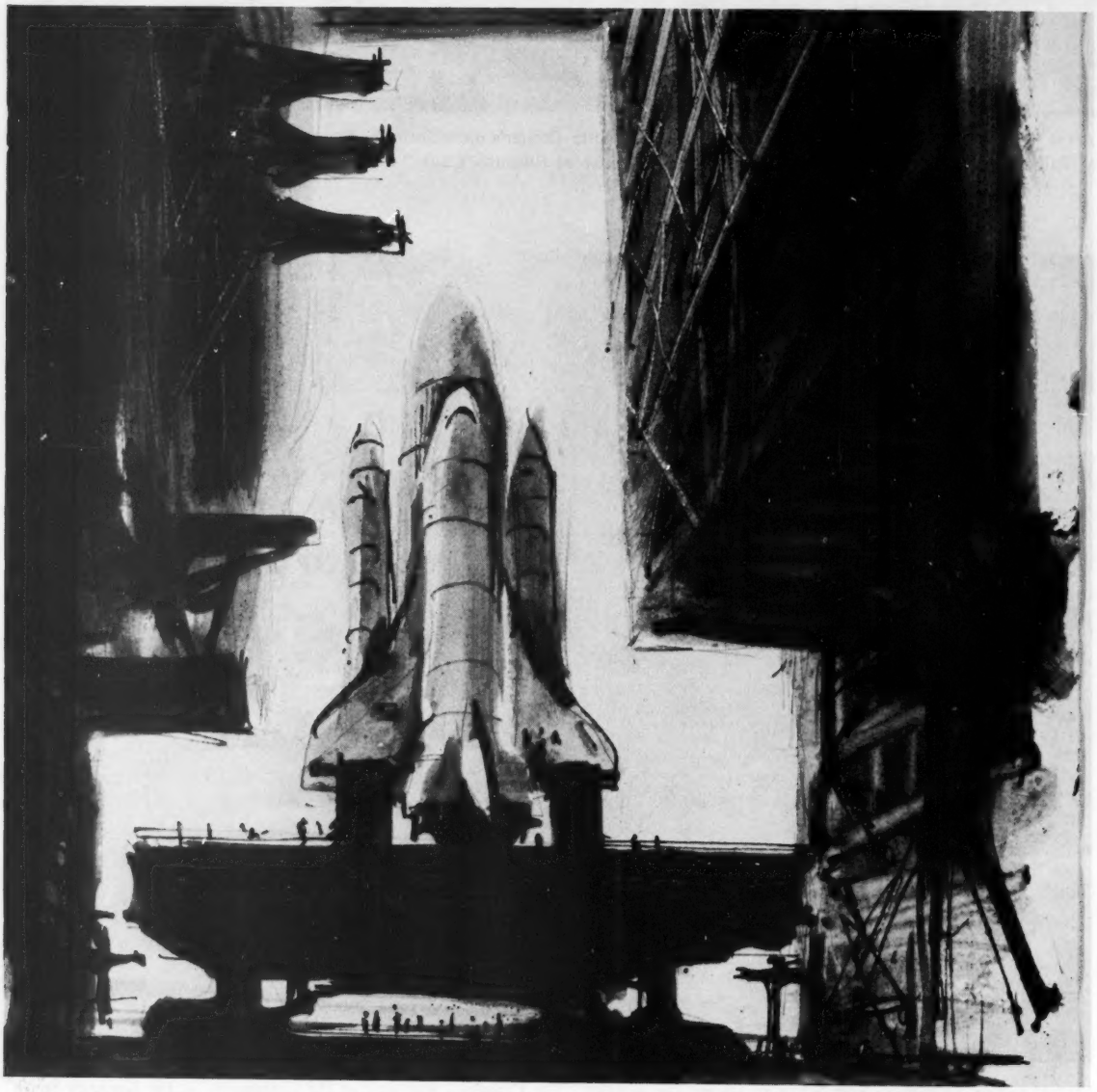


Artist Arthur Shilstone's prize-winning watercolor entitled "The Crawler—Roll Out of the Enterprise," at the Kennedy Space Center on May 1, 1979. Shilstone recently received a Certificate of Merit from the New York Society of Illustrators for this work.

covered the Orbiter ground vibration tests at Marshall Space Flight Center in 1978. NASA also commissioned artists Nicholas Solovioff and Arthur Shilstone to produce art of Shuttle activities including the roll out of the Orbiter on May 1, 1979 at Kennedy Space Center.

NASA plans to use a team of artists to cover the first launch and landing of the Shuttle Orbiter *Columbia*. In addition, artists also will go on assignment to cover aeronautics activities and other subjects of interest throughout the agency.

Recently, Arthur Shilstone as artist and NASA as client agency received Certificates of Merit from the prestigious New York Society of Illustrators at their 22nd Annual Exhibition held March 14–April 10. The artist painted a dramatic watercolor of the Shuttle transporter while on assignment at KSC during the roll out of the *Enterprise* May 1979. The painting, entitled "The Crawler—Roll Out of the Enterprise," will appear in the Society's 1980 art annual and has been on an international exhibition tour which included Japan and China.



Artist Nicholas Solovioff's watercolor of the Space Shuttle *Enterprise* leaving the Vehicle Assembly Building at Kennedy Space Center on May 1, 1979.

Lewis Computer Facility Dedicated

The nation's leading computer center for aeronautical propulsion research was dedicated May 29 at NASA's Lewis Research Center, Cleveland, Ohio. The new facility, called the Research Analysis Center, will greatly enhance Lewis' capability to design new and improved versions of aircraft engines and favorably impact other areas of the Center's energy-conversion activities.

"The RAC enables NASA to 'build' computer models of jet engines and other energy-conversion systems before having to commit extensive time and money to building and testing actual hardware," commented Lewis Director Dr. John F. McCarthy, Jr. "Moreover the facility eventually will serve NASA needs across the nation as well as interests of the scientific community at large. This will be possible through expansion, which is provided for in the building design and sophisticated linkages, some through satellite, with companion computers in various parts of the country," he said.

The two-story, 66,000 square-foot building features the fastest computer built by the IBM Company, the 370/3033 unit, which will help produce a tenfold increase in the speed of the Lewis Center's computational capabilities. The RAC is the first major research addition at Lewis since 1967 and boasts the most energy-conservative design of any building in the NASA organization nationwide featuring a waste-heat recovery system, high-pressure sodium lighting, extensive building insulation, and reduced window-area exposure. Waste heat from the computer operations will be used to heat the computing room, offices, and service areas. The recovered heat will be "stored" in a 70,000-gallon water tank buried just below the mechanical equipment portion of the building. RAC's sodium lighting is expected to reduce consumption of electricity for lighting by 60 percent over conventional construction. The building walls are constructed with insulated hollow cores of concrete blocks and, in addition, three inches of insulation have been applied to the inside surface of exterior walls. The roof is inversely insulated with a three-inch thick layer of stiff, closed-cell material installed above the roofing surface rather than below it as in conventional structures. RAC's

window-area exposure is about one-third of conventional design.

Lewis officials said that the new building cost $6 million to build. An additional $7.4 million was spent for new equipment including the new IBM 370/3033 computer. Construction was completed on schedule and within budget. Six Cleveland firms were principals in the design and construction of the Research Analysis Center:

- Madison & Madison International, architects
- Hoag Wismar Partnership, architects
- Turner Construction Co., construction management
- Roediger Construction Inc., building and site work
- Reliance Mechanical Corp., mechanical work
- Hatfield Electric Co., electrical work.

Some 150 leaders from local government, business, universities and civic organizations took part in the dedication, touring the new computer operations after Dr. McCarthy ceremonially cut ribbon-like streamers of computer tape to officially open the RAC for business.

KSC Sanctuary for Endangered Species

Florida has become the last refuge for the manatee (sea cow), an endangered species with numbers decreasing at an alarming rate. Brevard County, in which the Kennedy Space Center is mainly located, has the highest incidence of manatee deaths in the state. This alarming statistic has caused NASA to focus its attention on this native Floridian and to take steps to ensure its survival in the brackish rivers and lagoons surrounding the nation's Spaceport.

The manatee is a large, ponderous aquatic mammal, shaped much like a fat cigar with two small, front flippers and a broad, spatula-shaped tail. Strictly vegetarian, these gentle creatures can consume up to 100 pounds of food per day, may grow to over 12 feet in length, and can weigh over 1,000 pounds.

Because it is a mammal, the manatee must surface every few minutes to breathe. The slow-moving animal usually raises its snout just above water, making it an extremely vulnerable and well-hidden target for fast-moving motorboats. Most adult manatees bear the scars of a close encounter with their destructive neighbors. Boating accidents caused one-third of all manatee deaths last year. The manatee has no natural enemy today, except for human carelessness or vandalism. Man accounts for about half of all manatee deaths. Herbicides and spreading shoreline development are gradually destroying their feeding and breeding grounds. The greatest culprit, however, is the powerboat's lethal propellor blade.

Even the Space Shuttle program has made some allowances for manatees—changes which will benefit both parties. NASA will be using ships outfitted with a jet propulsion unit to recover the spent rocket boosters after they are jettisoned from the Shuttle and impact some 150 miles off the Florida east coast.

The recovery ships, large trawler-like vessels, will be docked in one of the manatee's favorite feeding grounds in the Banana River. The jet propulsion unit will enable the crew to maneuver the ship in any direction at a low speed without the use of the ship's large propellers. Not only will these propulsion units be safer for the manatees, but they will be useful in retrieving the boosters at sea. By switching to jet propulsion, the possibility of parachute lines becoming entangled in spinning propellers will be eliminated during the recovery procedure.

NASA has undertaken several projects to study and thereby help the manatee. Space technology was used to develop tracking devices which permitted wildlife workers to monitor the routes travelled by individual animals. NASA funded aerial surveys in and around KSC to learn more about populations and group migratory habits. These studies have provided valuable insight concerning warm and cold weather feeding grounds, permitting KSC engineers to schedule work in specific areas when the manatees will be absent.

In addition, anyone who operates a boat under U.S. Government control in KSC waters must take a manatee-training class, taught by the U.S. Fish and Wildlife Service. This course has also been taught to area Coast Guard members, who will hold classes for the general public.

At one point, manatees flourished throughout the coastal states of the southeastern United States, but were hunted extensively for their meat, blubber and ivory-like bones. Their numbers dwindled to the point where the entire U.S. population, estimated at about 1,000, now lives in Florida waters. Manatees have been protected by state law since 1893 and the Marine Mammal Act of 1972 bans hunting them in U.S. waters.

Motion Sickness Prevention

Prevention of motion sickness might be learned much as a person learns to balance and ride a bicycle, says a NASA scientist who has studied responses to motion sickness in more than 100 subjects. If your brain has something akin to the sound of a wrong note to tell it when your body is "off-key," you can learn to control physiological responses to motion, such as nausea, according to Dr. Patricia Cowings, psychophysiologist at NASA's Ames Research Center, Mountain View, Calif.

Cowings believes she may have a technique for dealing with motion sickness induced by the weightless environment of space. About half of all astronauts who have flown in space have had some symptoms of motion sickness.

Working at the Ames biomedical laboratories, Cowings and her associate, William Toscano, have taught about 50 volunteers to suppress illness when subjected to an ever-faster spinning chair. Another 60 subjects were studied without the training. Eighty-five percent of the trained subjects improved their ability to withstand motion. Sixty-five percent were able to completely suppress illness symptoms. The other 20 percent were able to withstand a significant increase in revolutions per minute before becoming ill. The 60 subjects who received no training represented the control group. No one in that group showed any significant improvement with time.

Ames laboratory assistant Leah Schafer, of Kalamazoo College, Kalamazoo, Mich., is strapped into a vertical acceleration device by Dr. Patricia Cowings. The vertical motion simulator is one of the devices used by Cowings to induce motion sickness in human volunteers.

The trained subjects monitored their own bodily functions such as respiration and heart rate during the course of the experiments. This biological feedback system has been used by other researchers and often produces significant positive results.

Biofeedback was used with the trained subjects in the spinning chair. Once they were trained to detect the biological signs of the onset of motion sickness, 65 percent of the trained subjects were able to suppress the illness symptoms.

Advantages of biofeedback over conventional treatments for motion sickness (drugs are usually administered) include an absence of side effects such as the sleepiness common with some drug therapy.

Cowings would like to test her theories in space and has proposed an experiment which has tentatively been selected along with other life-science experiments for the first two life-science Spacelab flights. Cowings' space experiment would involve trained crewpersons who would wear a biomedical harness feeding eight separate channels of a small portable data recorder. The recorder would collect information about the subjects' heart rate, skin resistance and other factors. If the subject could not suppress the onset of motion sickness symptoms, they would mark the recorder at the point where they became sick. This would enable Cowings and other researchers to study the tapes later and perhaps determine how the subject became sick or what physiological responses led to the sickness.

CATE Truck Visits Lewis

Besides the markings on its tractor and trailer panels, the muted and intriguing whirr of its powerplant tells the onlooker that this handsome black-and-white experimental turbine-powered truck is the only one in the country today demonstrating ceramic components.

Several dozen employees took turns riding in the truck's cab on its recent visit to the Lewis Research Center in Cleveland. Developed under the CATE (Ceramic Applications in Turbine Engines) Project,

The only turbine powered truck in the nation today demonstrating use of ceramic engine components recently visited the Lewis Research Center. The gas-turbine truck was developed under the CATE (Ceramic Applications in Turbine Engines) Project, managed by Lewis for the U. S. Department of Energy.

managed by Lewis for the U.S. Department of Energy, the truck's gas-turbine engine has 13 structural ceramic components, including regenerators, stator vanes and a turbine-tip shroud. The project contractor is the Detroit Diesel Allison Division of General Motors.

Ceramic components allow the gas turbine to operate at a higher temperature than do conventional metal parts, thus improving engine-cycle efficiency and fuel consumption, according to project manager Thomas J. Miller at Lewis. The basic engine is a Detroit Diesel Allison GT-404 all-metal gas turbine to which the ceramic components have been added to increase turbine inlet temperature from the standard engine's 1002° C (1836° F) to 1038° C (1900° F), with multifuel capability. In two future versions, the engine will be fitted with increasing numbers of ceramic components so as to operate at turbine inlet temperatures of 1132° C (2070° F) and 1241° C (2266° F).

When the project is completed in 1984, project engineers will compare fuel-consumption data for each of three ceramic configurations at progressively higher temperatures. Ultimately the 1241° C (2266° F) configuration is expected to reduce fuel consumption 20 percent compared with that of the conventional all-metal gas turbine.

The 1038° C (1900° F) version that visited Lewis is rated at approximately 300 horsepower, virtually the same as that of the standard GT-404. Road tests have been conducted with a trailer payload of 65,000 pounds, simulating commercial service. The engine is backed up by a four-speed automatic transmission, to provide a good balance of driveshaft torque for starts, acceleration, and hill-climbing as well as protection against engine-turbine overspeeding.

From Cleveland, the turbine-powered truck traveled on for stops and demonstrations in Pennsylvania and New York State, including the Corning Glass Work, in Corning, N.Y., where the regenerator materials used in the engine's ceramic components were made.

NASA's MATE Van

For over three years, NASA's Regional Remote Sensing Applications Program has been helping states and local governments use Landsat satellite data for natural resource and environmental management applications such as forest and agriculture inventories, urban and land cover analyses, water resources and coastal zone studies. To date, some 29 states have been directly involved in the program. Although the three responsible NASA Centers (Ames, Goddard, NSTL) have extensive in-house capabilities to support the program, the number of state personnel who can get the travel funds and release time to work at the centers has been limited.

Broader understanding of the ways in which Landsat data can be used must be achieved before the technology can be accepted as an operational tool and the support of policy-making officials both in state agencies and in the legislatures is particularly important. The Ames Research Center's MATE facility (Mobile Analysis & Training Extension) is a 30-foot mobile van with a stand-alone Landsat data analysis capability and a "have tapes will travel" commission to increase awareness of Landsat technology in the 14 western states for which Ames has the technology transfer responsibility. The heart of the system is a Hewlett-Packard HP 3000 Series 33 computer and the Interactive Digital Image Manipulation System (IDIMS) analysis software produced by Electro-magnetic Systems Laboratories, Inc. A full color interactive video display manufactured by De Anza, Inc., is the principal user interface of the system for reviewing the raw and processed Landsat imagery and overlaying it with the topography, geopolitical boundary, soils and other data frequently needed to address resource-management applications.

Inaugurated at a 14-state Landsat applications symposium in October 1979, the MATE van will be used in three ways; (1) to familiarize state governors, legislators and agency managers with satellite data; (2) to train agency personnel in image-analysis techniques needed to interpret Landsat data and relate it to other data sources; (3) to conduct short term demonstration projects on-site with state and local resource agencies.

On its first tour, the MATE van visited Sacramento, Calif., where legislators and state agency representatives participated in workshops and demonstrations. The MATE van then toured the Pacific Northwest where the use of Landsat data is rapidly becoming a useable tool for resource agencies in the three states. All three states are now building a capability to use Landsat data operationally. Governor Ray of Washington, Governor Evans of Idaho and Governor Atiyeh of Oregon, each visited the MATE van in their respective states to review the results of demonstration projects. An estimated

Traveling for the Ames Research Center, the Mobile Analysis and Training Extension (MATE) van spent two weeks this spring in the parking lot of the Colorado capitol, where Ames project representatives demonstrated how satellite technology can be applied to the state's environmental problems.

750 other individuals also visited the van in the three states including many key state legislators, agency heads and their staff. For many, it was a first exposure to the space technology to which their states are becoming committed.

MATE's second tour, completed in June, covered the states of Montana, Utah, Colorado and Nevada. Among the 650 state officials visiting the van and viewing Landsat demonstrations were Utah's Governor Scott Matheson and Nevada's Governor Robert List. Visits to the remaining states in the 14-state region served by Ames are scheduled to be completed by the end of 1980.

With resource and environmental management a priority need of state and local governments, the MATE van promises to be an increasingly effective tool to bring the vanguard of space technology to a wide cross section of diverse users.

Lewis Turbo Truck Fuel Efficient

An experimental turbocompound 450-horsepower diesel engine recently has demonstrated a four-percent improvement in fuel economy in a fully loaded tractor-trailer on nine consecutive round trips between Florida and Calfiornia for a total distance of approximately 50,000 miles, according to the NASA Lewis Research Center, Cleveland. Specially designed for heavy-duty trucks, the engine can potentially deliver a fuel-economy gain of as much as five percent under the most demanding conditions of maximum legal load and mountainous terrain.

The demonstration is the first known highway application of the successful aircraft-engine technology of turbocompounding. The project, funded by the U.S. Department of Energy (DOE), was managed by Lewis. Cummins Engine Company,

of Columbus, Ind., developed the turbocompound technology for highway use and supplied the engine.

The power plant's turbocompounding feature utilizes waste energy in a turbine driven by the diesel engine's own exhaust gases; the recovered energy is returned mechanically to the engine drive train. Mechanical coupling of the recovered energy distinguishes turbocompounding from the more common concept of free-floating turbocharging. In the demonstration engine turbocompounding and turbocharging were combined to maximize fuel economy. The turbocharger exhaust is ducted to a low-pressure turbine coupled to the engine's crankshaft by a speed-reduction gear train.

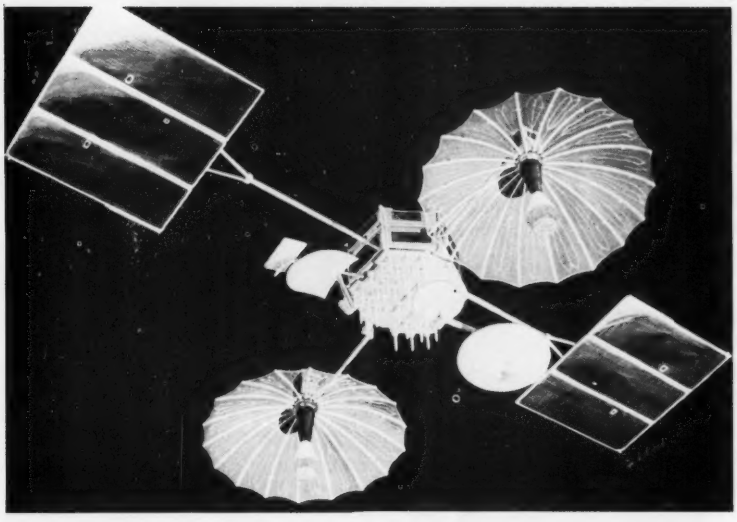
Operating at an average gross vehicle weight of 72,000 pounds, the truck turned in an impressive average fuel consumption rate of 5.25 miles per gallon for the nine trips. Its performance met test goals of the DOE Office of Transportation Programs in demonstrating reduced petroleum consumption while conforming to the more stringent 1980 California emission standards.

The truck was operated by Florida Refrigerated Services, Inc., of Dade City, Fla., as part of its scheduled freight service on the 5800-mile Florida-to-California round trip route. The truck's Kenworth tractor was selected from the car rier's regular fleet, the turbocompound engine having been installed at the Cummins facilities in Tampa.

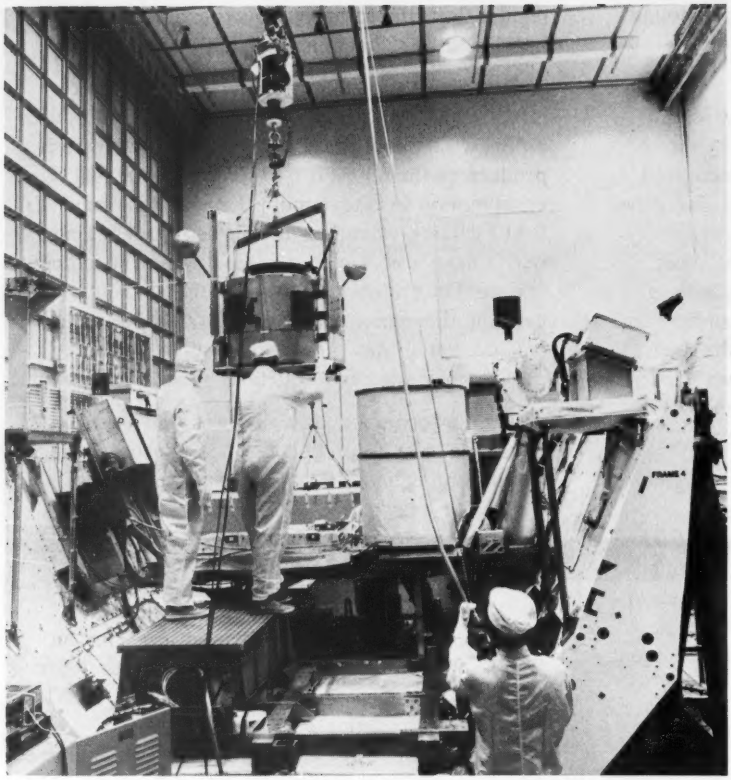
On its nine trips the tractor pulled a standard refrigerated trailer, loaded with frozen citrus juice on the westbound run to California and with fresh produce on the return trip to Florida. Total fuel consumption for the combined round trips was 9,817 gallons, estimated as four percent less than would have been required without the turbocompound feature. On a more demanding mountain route carrying the maximum legal load of 80,000 pounds, it is estimated that turbocompounding would provide a five-percent reduction in fuel consumption.

The turbocompound engine was derived from Cummins' 400-hp production model incorporating turbocharging and aftercooling, and was developed over a five-year period by Cummins at their Technical Center in Columbus.

In the search for further improvement in heavy-duty truck fuel economy, joint DOE/NASA/ Lewis/Cummins development work calls for an advanced turbocompound engine to be ready for on-the-road vehicle testing by the middle of 1981. The fuel-consumption goal of the advanced turbocompound truck will be a five-percent increase in vehicle tank range, based on the 5.25 mpg average fuel consumption attained in the recent 50,000-mile demonstration.



Tracking and Data Relay Satellite System—Artist's concept of the Tracking and Data Relay Satellite System (TDRSS) will consist of two specialized relay satellites in synchronous Earth orbit and a ground terminal located at White Sands, N.M. These satellites will relay data, commands, video and voice to and from spacecraft and the ground terminal. The TDRSS spacecraft and ground station facilities will support NASA Earth-orbital scientific applications and manned spacecraft missions including the Space Shuttle Spacelab and automated spacecraft to be inserted in orbit by the Space Shuttle in he 1980's.



Plasma Diagnostics Aboard Shuttle— NASA scientists in the clean room at Goddard Space Flight Center, Greenbelt, Md., lower a plasma diagnostics package aboard a Space Shuttle pallet. The experiment, built by the University of Iowa under a NASA contract, will be flown on one of the early Space Shuttle missions. The 329-pound plasma experiment will be maneuvered outside the bay of the Space Shuttle in flight by a remote manipulator arm to measure the electromagnetic field around the spacecraft. Upon completion of the experiment, the robot arm will ease the instrument back into the bay for return to Earth aboard the Shuttle. A total of 8,200 pounds of experiments are being placed aboard this particular pallet which will be stored in a clean room facility until the flight.

Kelly Hosts Aerospace Symposium '80

NASA's Aerospace Symposium '80 was held March 12-14 at Kelly Air Force Base, San Antonio, Texas. The symposium was designed to motivate students—especially females and minorities—to seek careers in science and engineering.

More than 2200 students, teachers, and counselors participated in the three days of seminars and workshops. A tour of Kelly Air Force Base also was held.

Seminars were conducted by JSC and Headquarters scientists and engineers. Topics included: Exploring the Outer Planets; Astronomy; Benefits from Space Medicine; Space Shuttle Program; and Solar Power and Future Space Systems.

NASA astronauts Frederick D. Gregory, Terry J. Hart and Judith Resnick presented awards to students who submitted outstanding science papers prior to the symposium. The papers were judged by JSC scientists and engineers. The symposium was acclaimed as a huge success. The enthusiastic response was demonstrated by the submittal of 485 science papers by the students.

The mayor of San Antonio, the Honorable Lila Cockrell, declared March 12-14 as "NASA Aerospace Symposium '80 Days."

Astronaut Judith Resnick signing autographs at the Aerospace Symposium '80 held recently at Kelly Air Force Base, San Antonio, Texas.

Spacesuit Backpack Fire Investigated

A NASA board investigating the April 18 flash fire in a spacesuit backpack found where the fire started and recommended numerous ways to improve the safety and reliability of the system.

The fire apparently started when the technician switched the secondary oxygen pack to the operating position during a performance test in a clean room in the Crew Systems Laboratory. The secondary pack is attached to the bottom of the main backpack to provide 30 minutes of emergency oxygen for breathing and to maintain suit pressure if the main oxygen source fails. Ignition took place in a V-shaped passage which restricts the flow of oxygen between a shutoff valve and a chamber in the pack's regulator module.

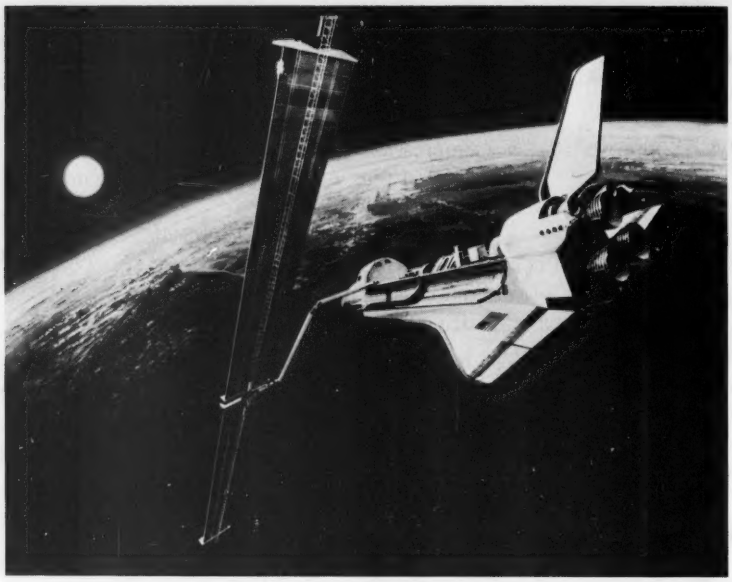
The board was unable to determine the exact cause of the fire after five weeks of engineering detective work that included more than 2,000 unsuccessful attempts to reproduce the fire. The board determined, however, the four most probable causes of the ignition and cited these in a report to Johnson Space Center Director Christopher C. Kraft, Jr.:

- Compression and/or shock heating in the flow restrictor between the shutoff valve and the capacitance volume, rupturing and igniting a thin section of aluminum.
- Compression and/or shock heating of contamination that was trapped in the stagnant volume of the flow restrictor.
- Mechanical heating of or by particulate contamination impinging on a surface.
- Compression and/or shock heating of one of the Silastic O-rings in the SOP shutoff valve.

The board found that all procedures followed during the April 18 test were proper. These tests are conducted to assure that malfunctions are discovered prior to flight, since such an accident during a mission might cause serious injury to the crew or damage to the space vehicle.

The regulator module contained 19 cycles of high-pressure oxygen prior to the accident. After ignition on April 18, the regulator module burned through and an oxygen-rich jet of flame burned the lower torso of the attached spacesuit. The board ruled out backpack and clean room electrical systems as ignition sources. It reported all clean room support feed lines were pure.

Two Ways To Go 50 Miles—Two vehicles in the vicinity of the Vehicle Assembly Building, Kennedy Space Center, Fla., are each capable of travelling about 50 miles on a single fill-up. But that's where the comparison ends. The most easily seen vehicle around the VAB (top right in photo) is the huge first stage of the Saturn V booster. Its five engines burned more than four million pounds of liquid propellants in two and a half minutes, burning out at about 50 miles from the launch pad as it lofted the upper stages and Apollo capsule moonward. The other and newer vehicle can also go about 50 miles from the launch area before it runs out of juice, but it's an electric van being tested at KSC to reduce rising energy costs. The mini-van, one of two recently delivered to KSC, uses conventional lead-acid batteries to power a direct current drive motor. The vans are expected to get about four miles to the kilowatt hour.



Shuttle Orbiter Solar Array System— Artist's concept of the Orbiter Solar Array System (OSAS), a solar panel designed to receive the Sun's rays and possibly add 22 days' life to a Shuttle mission. The OSAS would be deployed by the Shuttle's remote manipulator arm (shown in photo). Lockheed's Missile and Spacecraft Division and the McDonnell Douglas Corporation are working jointly on this study. When deployed, the system measures 80 m × 4 m (262 ft × 13 ft) but it collapsible to a stowage size of 1 m × 4 m (3 ft × 13 ft). The outer structure is constructed of fiberglass and the inner part is composed of a graphite epoxy material. The OSAS would be capable of producing a total output of 29 kilowatts of electrical power. This concept reduces the amount of liquid hydrogen and oxygen needed to run the fuel cells.

The accident destroyed an unoccupied Space Shuttle spacesuit and life-support backpack. A Hamilton Standard technician, Robert A. Mayfield, was severely burned but is recovering and has been released from the hospital.

Technicians were unable to duplicate the failure in tests at Johnson's White Sands Test Facility, Las Cruces, N.M. Four regulator modules of the same factory batch were cycled 2,228 times. Post-test disassembly revealed significant contamination within the modules.

A regulator module is machined from a single block of aluminum and is fitted with valves, a pressure gauge and two step-down regulators that reduce oxygen-supply pressure from 6,000 to 3.5 pounds per square inch. The flow restrictor, located between the high-pressure inlet and the first stage regulator, consists of two $\frac{1}{16}$-inch diameter drilled passages that intersect.

The safety improvement recommendations of the investigating board are:

- Redesign high-pressure oxygen valves and regulators so that debris cannot be trapped and eliminate "stagnation points" where heating by compression and shock can occur.
- Redesign regulator modules to lessen chance of internal contamination, while improving manufacturing inspection techniques.
- Review the design of all Space Shuttle high-pressure valves and regulators for debris traps and unprotected O-rings.
- Replace existing silicone O-rings with silicone O-rings having improved ignition resistance.
- Consider machining regulator module bodies from monel instead of aluminum to reduce ignition potential.
- Inspect completed regulator modules with X-rays.
- Consider using neutron radiography to confirm that O-rings and other non-metallic components with significant hydrogen content are properly installed.
- Machine a dummy regulator module body from a block of clear plastic to verify wall thicknesses and other passageway machining tolerances.
- Consider comparison impact ignition testing of Teflon or Kel-F backup rings as a means of reducing shock heating of silicone O-rings.
- Clarify internal NASA specifications.
- Consider establishing a committee consisting of NASA and non-NASA personnel to collect existing high-pressure oxygen data, review and clarify existing design standards and requirements, recommend any necessary supplements to presently available information and publish a comprehensive standard for the design and use of high-pressure oxygen equipment used in the space program.

In reviewing the board's report, NASA Deputy Administrator Dr. Alan M. Lovelace complimented the thoroughness of the investigation and said that the board's recommendations to improve the safety and reliability of the system will be followed.

The investigating board was headed by Chester A. Vaughan, propulsion engineer. Members were: Noel Willis, Jr., crew systems engineer; George D. Nelson, astronaut; Joseph Degioanni, flight surgeon; and James H. Chappee, safety engineer. Andrew J. Hoffman of Hamilton Standard served as ex-officio member, and R. L. Johnston, materials engineer, served as advisor.

Automated Advisory System Demonstrated

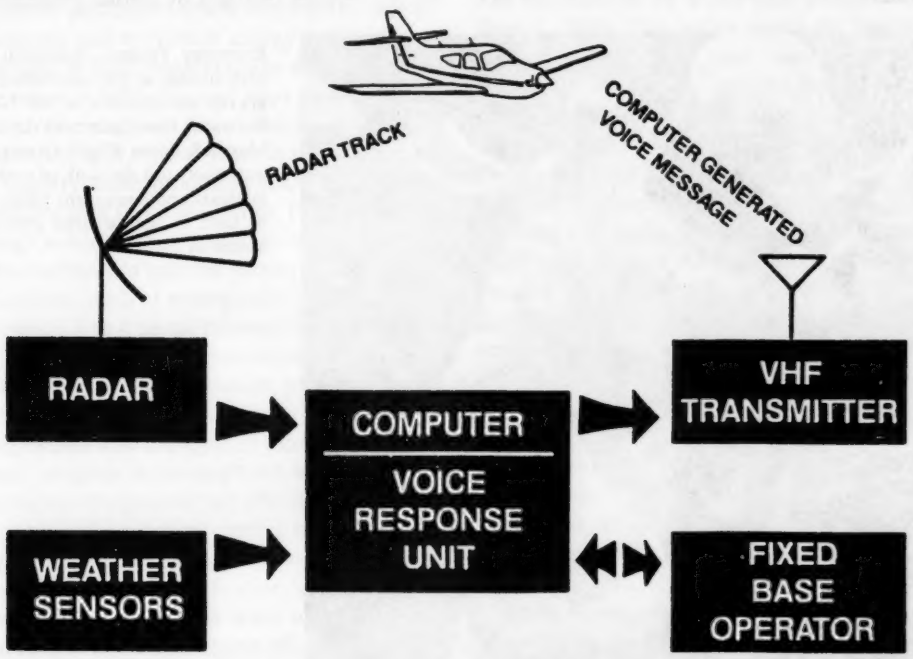
Flight demonstrations began in June at a Virginia airport of an experimental NASA computer advisory system which will expand the information available to pilots using smaller airports without control setups. The Automated Pilot Advisory System went into operation on June 23 at Manassas Municipal Airport, Va.

Designed as an extension of the procedural Visual Flight Rules system used at uncontrolled airports, the experimental system will help pilots keep track of other aircraft in the vicinity by supplying them with air-traffic information.

Computer-generated voice, radar and weather sensory information will broadcast automatically an airport advisory every two minutes and a traffic advisory every 20 seconds. To receive these advisories, the pilot need only to tune his radio to the proper frequency. The airport advisory will provide the airport identifier, broadcast time, wind speed and direction, favored or active runway, altimeter setting, and ambient and dew-point temperature. The traffic advisory will provide the number of aircraft on each pattern leg (final, base, downwind, crosswind or upwind), and position and heading of arriving or departing aircraft.

NASA's objective in performing the flight-demonstration tests at Manassas is to obtain an evaluation from pilots using the system in an uncontrolled high-density environment. The Manassas airport was especially suited for this demonstration because it is estimated that this airport handles approximately 200,000 operations per year—landings and/or takeoffs.

Principal elements of the experimental system are a radar set, a mini- and micro-computer, weather sensors, a very high frequency (VHF) transmitter and an operator control panel. The computers provide target detection and tracking, pattern classification, evaluation of weather-sensory data and generation of the several audio voice messages for transmission to aircraft.



Bauer Elected Corresponding Member

Dr. Siegfried J. Bauer, Goddard's Associate Director of Sciences, recently was elected a corresponding member of the Austrian Academy of Sciences.

Dr. Bauer, who was born and educated in Austria, has been working in the United States for the past 26 years. Prior to joining Goddard in 1961, he was Senior Research Scientist for the U.S. Army Signal Research and Development Laboratories, Fort Monmouth, N.J.

In addition to this present honor, Dr. Bauer is a Fellow of the American Association for the Advancement of Science, a Fellow of the American Geophysical Union, and a recipient, in 1974, of the NASA Medal for Exceptional Scientific Achievement.

L-1011 Vortex Flight Testing

Wake vortex flight testing with an L–1011 wide-body jet transport aircraft resumed June 9 at NASA's Dryden Flight Research Center, Edwards, Calif., in conjunction with the Federal Aviation Administration.

The tests, which will continue for several months, are aimed at reducing vortices, invisible turbulent air flows that stream in a tornado-shaped pattern from the flaps and wingtips of aircraft. For the wide-body class of aircraft, vortices can be severe enough to require time delays in takeoffs and landings at airports. As they also can interfere with other aircraft landing and taking off, planned time separations are currently imposed. If the vortices can be diminished, the reduction in traffic congestion could result in significant fuel and time savings.

Previous tests with a Boeing 747 transport indicate that it may be possible to break up vortices by selected use of the aircraft's ailerons and spoilers. The spoilers, which are normally used as speed brakes and to decrease the aerodynamic lift after landing, will be used in flight to disturb the vortices trailing from the wing flaps. The ailerons, which normally are used for turning, will be deployed to disturb the wing-tip vortices.

The L–1011 to be used in the tests is the Lockheed prototype certified with a direct-lift flight-control system that has the spoilers normally deflected at an upward angle of 8 degrees. The proposed vortex alleviation system is not greatly different from the present approved flight-control system already in use on the long range L–1011 aircraft.

The flight tests will consist of high-altitude probing of the vortices (marked by smoke generators) by

Buoyancy Testing—Astronaut Bruce McCandless in the neutralized gravity environment of the Neutral Buoyancy Simulator tank at NASA's Marshall Space Flight Center. The astronauts use the tank to evaluate methods and equipment which might be used to service large structural beams in space.

a small, highly instrumented NASA test aircraft. If the high-altitude tests are favorable, simulated landing approaches will be made to a runway on the dry lakebed at Edwards. A laser doppler velocimeter, radar-sensing system, and a ground-wind vortex-sensing system will be used to measure the trailing vortices in ground effect.

If the configuration changes to the L–1011 alleviate the vortices sufficiently, actual landings of the test aircraft at reduced separation distances will be considered.

Lewis Technology Transfer Conference

As many as 400 executives, leading researchers, and others representing a cross-section of large and small business and industry in greater Cleveland and northern Ohio convened May 14 and 15 at the Lewis Research Center, Cleveland to learn of the latest in aerospace developments that promise potential for meeting growing energy and other technological needs of the nation in the years ahead.

Attendees of "Impact for the 80's: A Conference on Selected Technology for Business and Industry" were briefed on a variety of potential commercial application opportunities from aerospace-based technology. The energy options set forth in some of the leading presentations, if even partially realized, could help ease America's task of maintaining economic growth and a competitive position in world trade in the face of pervasive national and worldwide energy problems.

Most dramatic of these presentations were those on wind power commercialization and solar photovoltaics, both foreseeing bold new technologies in practical use in the next several years in many places around the country, some producing electric power at costs competitive with those of utilities. For example, the technology would permit thousands of high-capacity wind turbines to spin out power in "farms" of 50 to 100 turbines, each at strategically located sites, at costs averaging 3 to 4 cents/kilowatt hour. The Jet Propulsion Laboratory speaker presented a bright future for solar cells producing electric power in various parts of the country.

Studied optimism was conveyed in other conference presentations: progress in development of Stirling and gas turbine engines for greater fuel efficiency for motor vehicles; a prospective practical electric or hybrid car on the road in the 1980's; and production of electric power by a high-sulfur coal gasification/cogeneration process that eliminates pollutants while using otherwise-wasted heat to maximize system efficiency.

The attendance of some 450 for the proceedings was the largest local group ever to assemble for a technology utilization conference at Lewis. Many attendees shared a common interest in managing problems of energy use in the day-to-day conduct of their businesses. In this important respect the conference was a significant event in Lewis' productive relationship with business and industry.

Contractor News

Canadian Astronautics, Ltd., of Ottawa, has been selected by Goddard Space Flight Center for negotiation of a contract to provide Local User Terminals to process signals from the search and rescue instruments aboard orbiting satellites. The contractor's estimated cost is $3,042,500. The first terminal will be installed at Kodiak, Alaska. Optional units may be installed at Scott Air Force Base, Ill., and the U.S. Coast Guard Station at San Francisco, Calif. The first set of equipment must be installed within 19 months after contract signing. The contract also provides for 15 months of maintenance of each unit after installation.

Computer Sciences Corporation, Applied Technology Division, Falls Church, Va., was awarded a $36,782,578 one-year extension on its communications and instrumentation support services contract by the Kennedy Space Center. The extension is for a one-year period that began June 1, 1980. This action marks the fourth year of service and brings the total value of the contract to $106,851,713. The cost-plus-award-fee contract calls for CSC to provide communications and instrumentation services in support of the Space Shuttle program.

Lewis Research Center has awarded to **TRW's Defense and Space Systems Group,** Redondo Beach, Calif., and **Hughes Aircraft Co.,** Los Angeles, parallel $1-million one-year contracts to develop a design concept for an advanced commercial communications satellite system. The system would be operated experimentally in the high frequency 30/20 gigahertz (GHz) bands and is expected to prove technology concepts, that, if implemented commercially, would meet the tremendous increase in U.S. telecommunications needs anticipated during the next two decades. These bands have not been used commercially to date in this country.

Ford Aerospace and Communications Corp., Houston, has been selected by NASA for

negotiation of a contract to perform the overall system design engineering of the Preliminary Operations Requirements and Test Support system for the Space Telescope. The contractor's estimated cost is approximately $9.2 million. The work is to be completed by December 1983 in time to support the Space Telescope Mission. Ford Aerospace will operate the system for six months before turning it over to NASA. Overall direction of the system is under the Office of Space Tracking and Data Systems at NASA Headquarters.

Rockwell International Corp., Downey, Calif., has been selected by NASA to conduct a design study of alternate thermal protection systems for the Space Shuttle Orbiter. The nine-month study is expected to cost approximately $900,000. The major goal of the study will be to determine if a more durable system, requiring less maintenance and a lower life-cycle cost, is or can be made available, based upon improvements in thermal protection system technology. Alternate systems to be studied will include metallic, ablative and reinforced carbon/carbon concepts. The contract will be managed by the Langley Research Center, Hampton, Va.

Launches for 1980

Name	Launch Date	Vehicle	Range	Mission Remarks
FLTSATCOM-C	January 17	Atlas Centaur	ESMC	DOD Navy. Reimbursable.
SMM-A	February 14	Delta	ESMC	NASA. Scientific Solar Maximum Mission.
NOAA-B	May 29	Atlas-F	WSMC	NOAA Weather. Reimbursable. Launch vehicle failed.
GOES-D	September 9	Delta	ESMC	NOAA Weather. Reimbursable.
SBS-A	October	Delta	ESMC	Satellite business systems. Reimbursable.
FLTSATCOM-D	October 28	Atlas Centaur	ESMC	DOD Navy. Reimbursable.
NOVA 1 (Navy 20)	November	Scout	WSMC	DOD Transit. Reimbursable.
Intelsat V-A	November	Atlas Centaur	ESMC	Intelsat communications. Reimbursable.

Patents for Inventions from NASA Research

The office of General Counsel, NASA Headquarters, announces that the following U.S. patents have been issued by the U.S. Patent Office to NASA for inventions resulting from NASA research. Inquiries concerning them should be directed to the attention of the NASA Patent Counsel of the indicated installation.

Inventor(s) & Employer	Title	Patent No.	Installation
Vincent G. Anicich, Wesley T. Huntress, Jr., Caltech/JPL	Miniature cyclotron resonance ion source using small permanent magnet	4,206,383	NRO/JPL
Porter R. Ryason, Caltech/JPL	Continuous coal processing method and means	4,206,713	NRO/JPL
Roland W. Lee, NASA/Langley	Retainer for murine specimens and test equipment	4,206,721	LaRC
William M. Hahlbaum, Jr., NASA/Langley	Chromatically corrected virtual image visual display	4,206,970	LaRC
Robert C. Bill, Lawrence P. Ludwig, NASA/Lewis	Composite seal for turbo-machinery	4.207.024	LeRC
Paul M. Sawko, NASA/Ames	Structural wood panels with improved fire resistance	4,209,561	ARC

Did You Know?

Two new NASA special publications have been released: "Volcanic Features of Hawaii: A Basis for Comparison," by M. H. Carr and R. Greeley (NASA SP-403), and "The Apollo Spacecraft: A Chronology—Volume IV: January 21, 1966–July 13, 1974," by I. D. Ertel and R. W. Newkirk, with C. G. Brooks (NASA SP-4009). "Volcanic Features" serves as a photographic guidebook to the volcanic features of Hawaii and Mars. As the book emphasizes the photography, the text is deliberately short. The book opens with a brief overview of Hawaiian volcanoes followed by several chapters illustrating different features of that state's volcanic structures. The book's second half covers Martian geology and volcanic features. This casebound book is 218 pages and contains 175 black and white photographs. It is for sale by the Superintendent of Documents, U.S. Government Printing Office, for $14. "Apollo Spacecraft" is the final volume from the Johnson Spacecraft Center and details the chronological history of the major events and managerial decisions that culminated in the Apollo spaceflight program. Volume IV covers the period from January 21, 1966 through July 13, 1974—a timeframe during which the following events took place: all flight tests of the Apollo spacecraft, the last five Gemini flights, the tragic fire that claimed the lives of three astronauts, the manned Apollo flight program and its results, and the use of the Apollo spacecraft for the Skylab missions. This paperbound book is 482 pages and is for sale by the Superintendent of Documents, U.S. Government Printing Office, for $11.

NASA has instituted a **flight equipment data bank.** The computer listing provides a reference and point of contact for identifying space equipment currently flight-qualified or -qualifiable which may be used for future space experiments, reducing the cost for new development efforts. Listings do not imply NASA endorsement. Equipment listed includes items that have been launched or successfully flight qualified within the last two years or which are under contract with a projected launch date and will be flight qualified prior to that time. The listing includes the mission with which the equipment is associated, the date of launch and the manufacturer. Users requesting this information should write the Office of the Chief Engineer, NASA, Washington, D.C. 20546. Companies which manufacture flight-qualified or -qualifiable equipment can obtain information on registering these items by writing to the above address, or by calling Ben Bernstein, Assistant Manager, Parts and Materials Program, Program Assurance Division, Office of the Chief Engineer 202/755-3290.

Idea Clearinghouse, an internal voluntary pilot program designed to spread the word on good management ideas, this month cites the Ames Research Center's Procurement Management Technology Program, an automated purchase order information system developed by the Headquarters Office of Procurement. The program enhances procurement operations by taking advantage of the latest data-processing techniques. Joe Rokovich of Ames Procurement Division explains that the information system allows users at remote terminals to query the controlled data base for the status of purchase requests for dates of award or delivery, as well as other variables, by following a programmed set of instructions. Another currently operational feature uses a high speed printer that eliminates the manual preparation of purchasing documents. The Photographic Technology Branch at Ames is one satisfied user enjoying the benefits which result from faster response times to questions on the status of purchases for their many customers. (For more information contact Headquarters: Dr. Neil Lamb, FTS 755-2060 or the Information Systems Division, 755-3219.)

Another Dividend from Air and Space

Research and development in aeronautics and space have provided numerous benefits for all Americans—and at a tiny percentage of the tax dollar. Here is an example:

Foldable Walker

Paraplegics, who number about 100,000 in the United States, depend on crutches for their mobility on level ground. But crutches are ineffective on stairways; for climbing or descending, the paraplegic needs a stable pair of rails to push against. Aluminum metal walkers are designed for use on level surfaces, hence they have little utility on stairs; and, although lightweight, they are too heavy to be carried by the paraplegic while walking on crutches. There exists a need for a walker specifically designed for stair use and made of a material much lighter than aluminum.

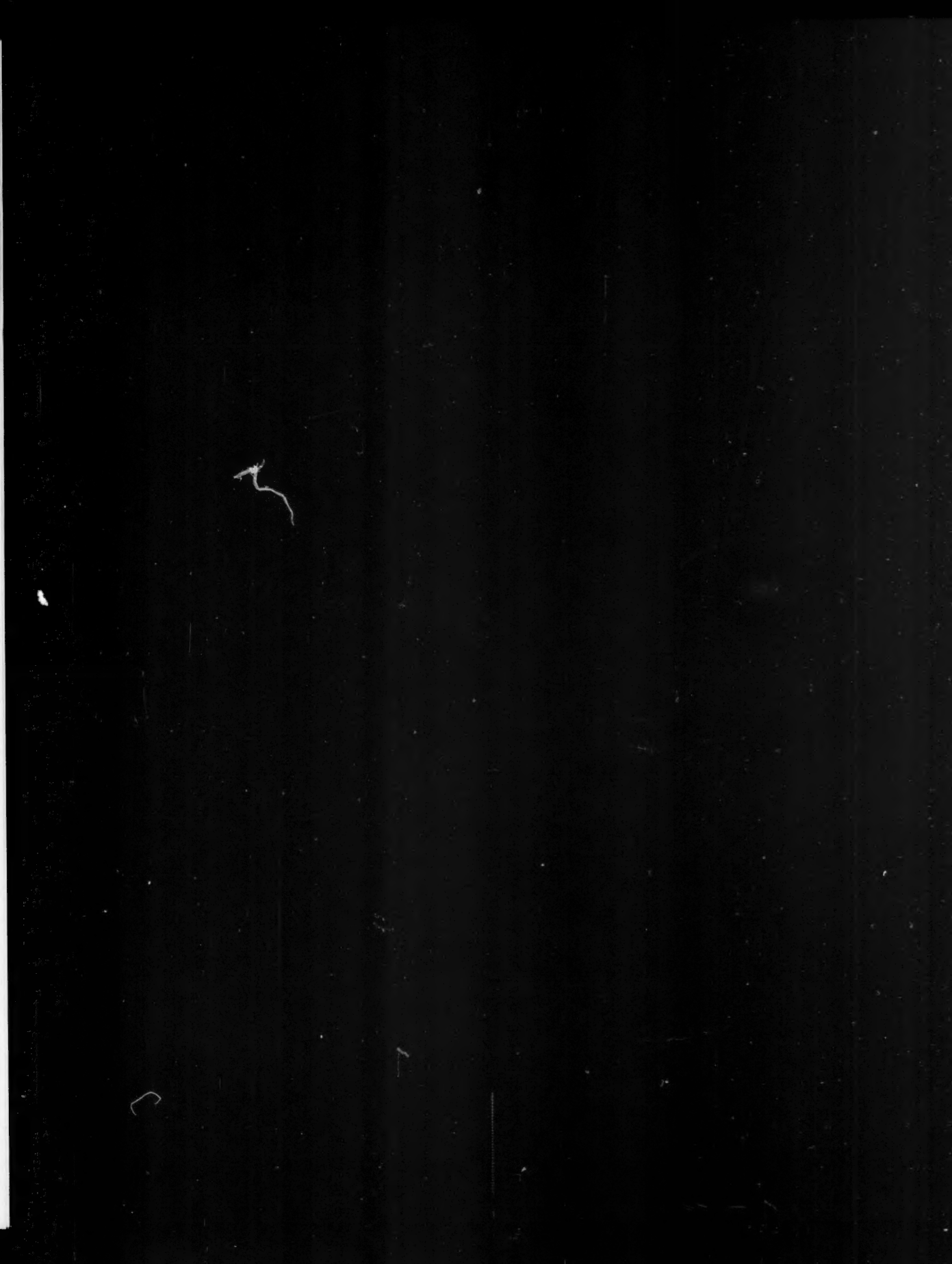
Engineers at Langley Research Center teamed with Dr. Ernest Harrison of the Mississippi

Methodist Rehabilitation Center in a community service project involving development of a very light walker that is foldable for easy carrying. The prototype stairwalker * is based on composite materials being developed by NASA for aircraft and spacecraft. The material selected was a graphite-epoxy composite which is stronger yet 50 percent lighter than aluminum. The developers made the front legs eight inches longer than the rear legs to fit the uneven surfaces of a stairway.

Dr. Cynthia Morris (shown in photos), a professor at American University, Washington, D.C. and a paraplegic, has been evaluating the composite foldable walker for more than a year. She reports that it is light enough to carry while walking on crutches, it forms a stable platform to assist her in ascending and descending stairs, and it has significantly improved her mobility and independence.

* NASA does not endorse commercial products developed as a result of its Technology Utilization or Patent Licensing Programs, but it does encourage the widest possible use of such technology.

NASA
National Aeronautics and Space Administration

For the benefit of all . . .

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